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The Longest Bridge in the World—

of its width; 550 feet long—4½ feet wide. It connects Vesper Country Club on Tyng's Island with the mainland and has an automatic turnstile operated by a nickle-in-the-slot mechanism.

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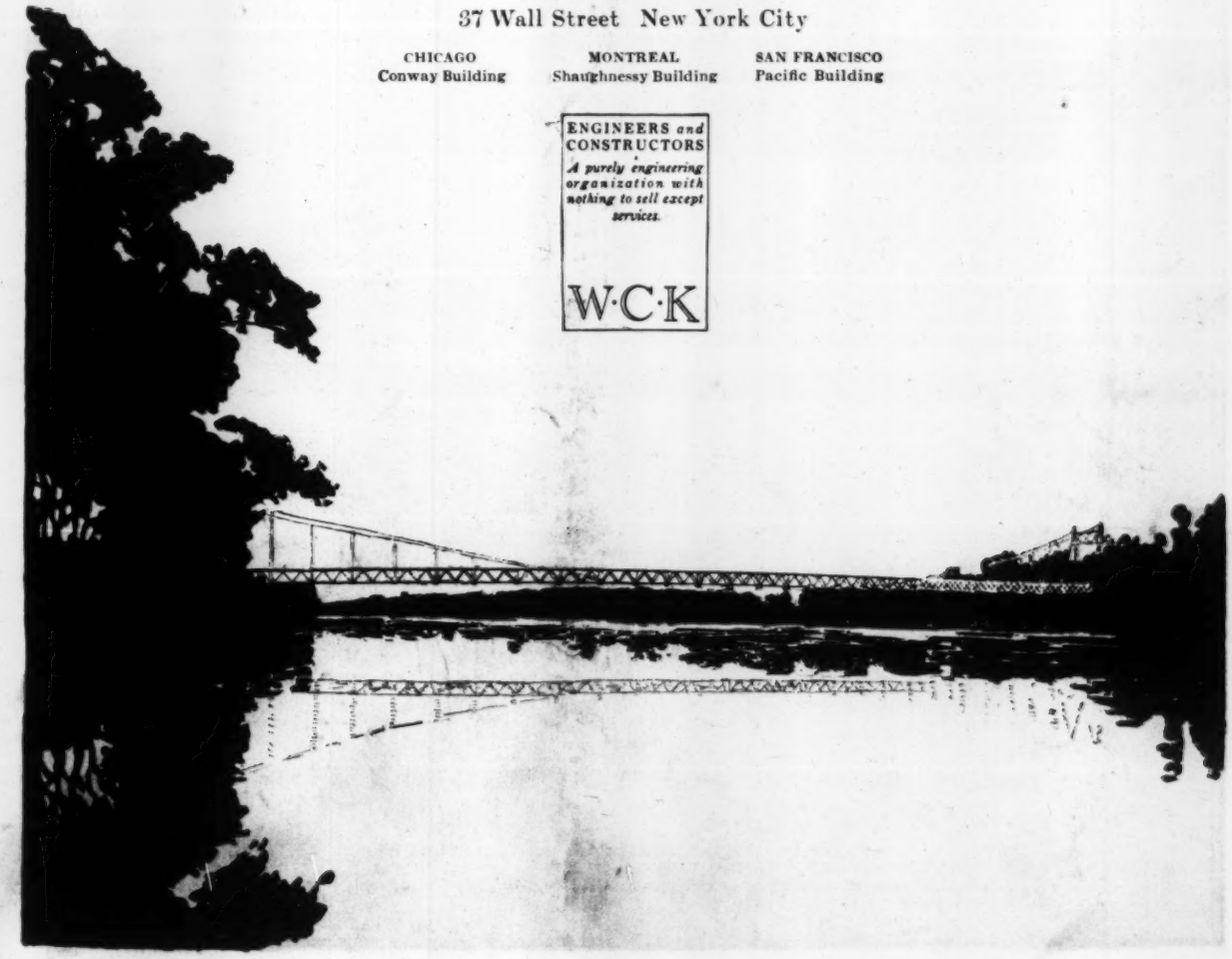

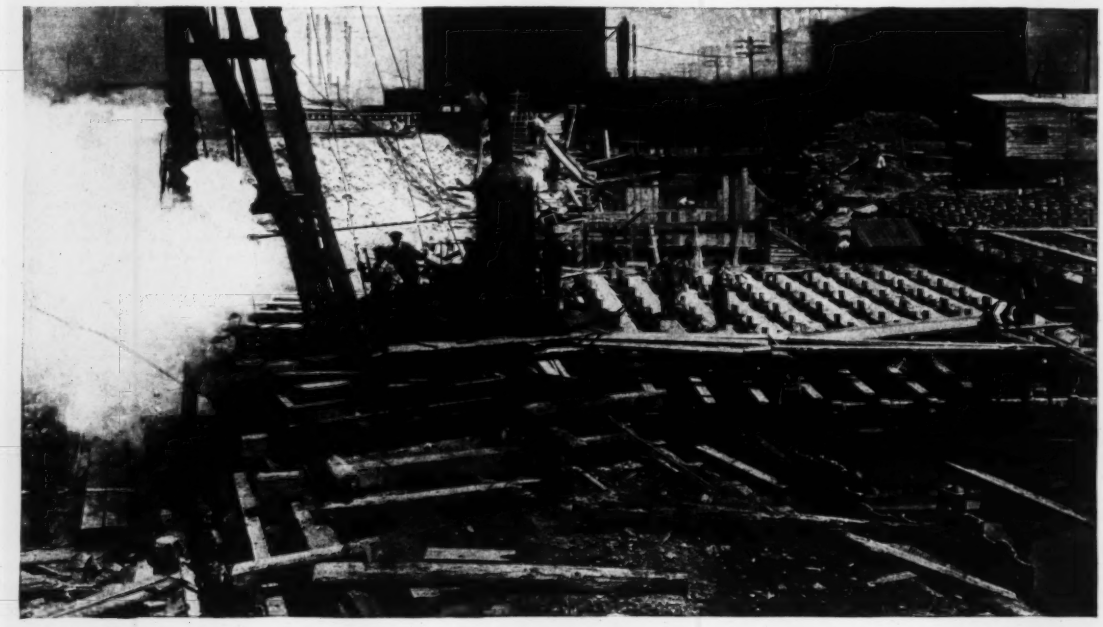

The Permanent Installation of Lackawanna Steel Sheet Piling, Under The New Lehigh Valley R.R. Passenger Terminal, Buffalo

This new 4-story fire-proof building is on a site across which flows the old Hamburg Canal, recently roofed over and converted into a sewer.

Bad condition of its walls and unstable underlying ground made careful protection of this sewer essential in excavating on either side. Two parallel walls of Lackawanna Steel Sheet Piling were therefore driven one on each side, as close as possible to the underlying rip-rap, but without disturbing this material.

The line of the sewer foundation was irregular and in some places the obstructions were very annoying but the Lackawanna Sheet Piling was in all instances driven to as great penetration as was necessary (28 to 34 feet.)

Although the sewer was constantly full of water, there was no trouble from leakage through the sheet piling after the adjoining excavations were made. The sheet piling behaved well throughout, and in the few places where solid rock obstructions were met the piling tops were burned off to an even line. All of this Lackawanna Sheet Piling is now covered up and left in place to permanently strengthen the sewer walls and protect the adjoining excavation.

This work was carried out under the direction of E. B. Ashby, Chief Engineer of the Lehigh Valley R. R. from designs by Kenneth Murchison, New York, and the contractor was J. Henry Miller, Inc., Baltimore.

Protection of foundation work and adjoining structures during excavation is frequently accomplished most economically by Lackawanna Steel Sheet Piling, and our engineers are always ready to advise on difficult installations. Ask for our book—"Lackawanna Steel Sheet Piling."

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Engineering News

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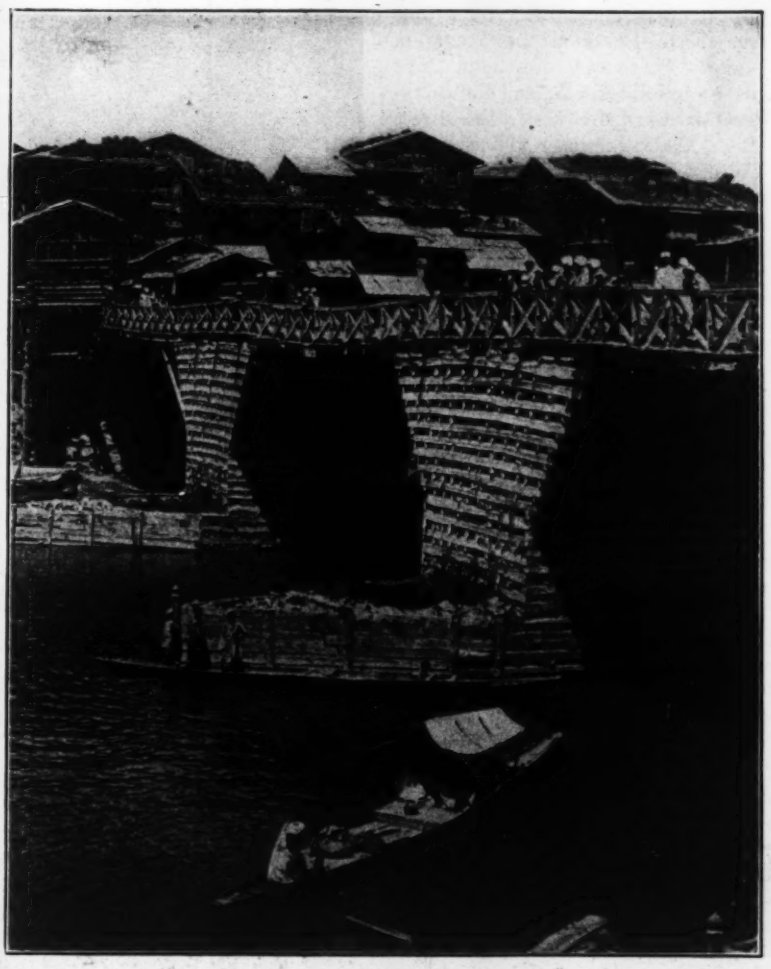
Primitive Timber Bridge in the Vale of Cashmere

Such structures as the one shown in the accompanying view as a rule have only a pictorial or historical interest, but this particular one would seem to hold a suggestion, at least, for a temporary bridge even in civilized countries, or at least as an expedient in some location where carpenters are scarce or cut timber difficult to obtain. The bridge is across the Velasla River at Srinagar, in Cashmere. As may be noted, its novelty consists in the corbeled piers which reduce the clear span to such an amount as to permit the use of single timber girders for the main spans, in effect producing a cantilever bridge of the simplest type. The piers are made up of cribwork filled up to the beginning of the corbeling with riprap or stone. Above that point apparently no filling is used, but the floor is carried on the cribbing itself. The cut-waters, also of filled cribbing, which form pier footings, extend up to high water in the river. What is presumably the same bridge is illustrated by a sketch in Tyrrell's "History of Bridge Engineering," but the view there shows the roadway covered with small frame buildings similar to those in the background of the view herewith. It is stated that these are used as stores and the structure is locally known as "the bridge of shops." Possibly these buildings have since been removed for they do not appear in this later view.



TIMBER CRIB CANTILEVER BRIDGE ACROSS THE VELASLA RIVER IN CASHMERE, INDIA

In considering the design of this unique structure it is well to bear in mind that the Vale of Cashmere is located high in the remote fastnesses of the Himalaya Mountains. The lake into which the Velasla River empties is over 5,000 ft. above sea level. In this distant region, manufactured articles of iron and steel are of course exceedingly expensive and difficult to obtain. The designer of this bridge, therefore, appears to have utilized to the best of his ability the local materials, timber and stone, which were most readily available. One does not have to go more than a century and a half back in European civilization even, to reach a period when engineers were almost as closely limited in the materials available for construction and in the tools for handling them as was the designer of this bridge. Except for the masonry arch structures, therefore, some of the bridges built in civilized countries a hundred and fifty years or more ago, were almost as crude in design, according to our present-day notions, as this bridge in the Vale of Cashmere. In masonry arches, of course, the present has little advantage over the past.

Park Grading by Day Labor

SYNOPSIS—Artificial topography on a flat park site, the work including steam-shovel and elevating-grader work with both dump-wagons and dump-cars. All done by the forces of the West Chicago Park Commission.

A grading job of 271,000 cu.yd. is involved in the lay-out of Columbus Park, Chicago. This is a new park established in vacant land on the outskirts of the west side, with a rectangular area of about 154 acres.

The site is flat, and the grading is for the landscape-engineering work, including excavation for a large lagoon and open-air swimming pools. The excavated material is being banked up around the sides of the park so that, with the trees and shrubbery upon this fill, the surrounding buildings will be largely concealed and the interior of the park given a rural appearance. The West Chicago Park Commissioners decided to do all the excavation and grading with their own forces and equipment. The design of the park, with its buildings, etc., and the carrying out of the construction work are under the direct charge of A. C. Schrader, Chief Engineer and Superintendent of the West Chicago Park Commission.

The surface is a thin cover of black soil over a bed of stiff blue clay. Test pits 3 ft. square were dug in order to determine the material to be handled. The black soil is stripped and saved for spreading over the golf grounds and the slopes of the new fills. In this way the cost is only about 40c. per yd., while new black soil would cost $1 per yd. The stripping is done by a New Era elevating grader, which is hauled by a Reeves 12-ton 20-hp. steam traction engine, the soil being delivered into dump-wagons. Where the machine could work continuously on long stretches, as in stripping the site of the fill, it could load 800 to 900 wagons per day (900 to 1,000 yd.). This outfit is shown in Fig. 1.

The main excavation, for the lagoon, etc., is in the stiff blue clay. Very little water is encountered, and this is carried off by a ditch in the floor of the cut, while a gasoline diaphragm pump is provided at the sump. This excavation is done by two 15-ton Erie steam shovels, of the revolving type, with ¾-yd. buckets. The maximum depth of cut is 14 ft., which is made in two lifts. The steam shovels are served mainly by small dump-cars, but dump-wagons were used on some parts of the work. These shovels excavate 700 to 800 yd. per day. Fig. 2 shows one of the shovels making the first lift of the deep cut and loading the material directly into the dump-cars on the surface of the ground.

There are about 1½ mi. of track of 20-in. gage, consisting of 20-lb. rails spiked to 4x6 ties 36 in. long and spaced about 36 in. c. to c. The cars are of the side-dump type, of 1½ yd. capacity, and are made up in five-car trains, each hauled by a two-horse team. Locomotives were not considered advisable, as much of the track is on the fresh fill and would not carry heavy loads, besides which the grades are very irregular. With teams, the

FIG. 2. STEAM SHOVEL EXCAVATING FOR THE LAGOON IN COLUMBUS PARK, CHICAGO

trains are handled easily, and the light construction makes a very flexible track layout that can be shifted readily as the work progresses.

The grader outfit has five men at the machine—foreman, engineman, fireman, one man on the grader and one to take care of stumps or boulders. At the dump for the wagons with black earth a boss and six laborers spread and level the material. This outfit is served by 20 to 26 teams. Each steam-shovel outfit has an engineman, a fireman, two pitmen to shift the supporting platforms under the wheels and two topmen to see to the loading of the cars. At the dump (for the cars) there are 12 to 16 laborers to shovel the fill. Each shovel is served by 8 to 14 teams (each with a five-car train), depending upon length of haul.

The grader wagons average 1.12 yd. per load, and the dump-cars average 1.4 yd. Count is made of the number of dipper loads, and this is checked by the cross-

FIG. 1. STRIPPING BLACK SOIL FOR USE ON GOLF GROUNDS AND LAWNS AT COLUMBUS PARK, CHICAGO

section measurements. The monthly record is from 12,000 to 16,000 cu.yd. for each shovel and 16,000 yd. for the grader.

The depth of water in the lagoon is about 6½ ft. The normal bottom width is 125 ft., and the side slopes are 1 on 3. On each slope there is a 4-ft. berm about 12 in. below the water. This retains a 2-ft. facing of black earth on the upper slope, thus enabling shrubbery to be grown along the water's edge, instead of leaving a bare margin. There will be a boathouse and landing, gymnasium, shelter and other ornamental structures. The swimming pools will be 50x70 and 50x140 ft., and the children's wading pool 40 ft. in diameter with a sand court surrounding it.

The fill at each end of the park is about 85,000 yd. This serves to conceal the surrounding buildings, and for the same purpose the entrance driveways are cut diagonally through the fills. At the east end, where a playground is located outside the fill, space is gained by the

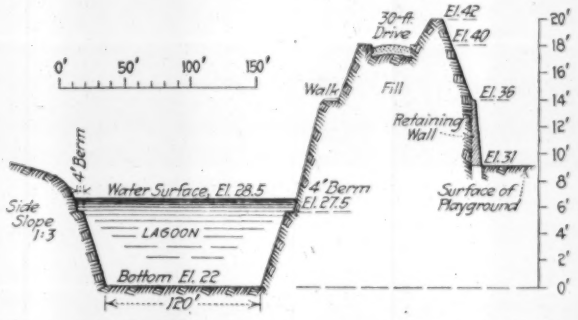


FIG. 3. DISTORTED SECTION THROUGH LAGOON AND FILL AT COLUMBUS PARK, CHICAGO

use of a concrete retaining wall to hold the fill. Fig. 3 is a section through the lagoon, fill and retaining wall. The drives are 30, 50 and 60 ft. wide, the maximum width being at points where it is desired to allow for the parking of vehicles.

For subsoil drainage of the golf grounds, drains of 4-in. tile are to be laid at a depth of about 3 ft. These will lead to a vitrified-pipe sewer along the north side of the park. The city needs additional sewers in this district, and to save duplication and expense the sewer was built of such size as to form part of the sewerage system, and the city paid a portion of the cost. This sewer was built by contract, as the cost of trenching machinery would have been out of proportion to the amount of work.

The site is crossed by Harrison St., but the city vacated the street for park purposes, the Park Commission undertaking to build a new connecting street around the south end. A 20-in. gas main exists on the original street line, but the gas company would not agree to shift it to the new street location. To avoid injury to trees and shrubbery, the main was uncovered and all joints were thoroughly calked and then clamped with a special gas-tight clamp. For crossing the lagoon this main had to be lowered about 16 ft. for a distance of 250 ft. The new trench for this was dug by a trenching machine.

About 110 men (including teamsters) and 50 teams are employed. They work a 9-hr. day (7 a.m. to 5 p.m.). The temporary buildings on the work include an office for the superintendent, timekeeper, etc.; an office for the foreman, a storehouse, a shelter for the men in case of storms, and stables for the teams.

The Engineer as a Juror

By R. Fleming*

It is the contention of the writer that the engineer is peculiarly well qualified to act in the capacity of a juror. Trial by jury is one of the foundation stones of the English and American constitutions. It is said that the system has been abused. Few changes are likely to be made, however, in the present generation. The remedy for any abuses that may have crept into the system is to raise the standard of jurors. It is hard to do this when men of the type needed avoid service. "And they all with one consent began to make excuse" may often be said of a body of intelligent men drawn to do jury duty. The result is that decisions of importance are left to men of narrow vision and poor judgment.

"I am a roofer. I get $2.25 a day at my trade and work is dull, so I do not lose anything by serving as a juror," was the remark made in a courtroom to the writer by the occupant of the adjoining chair. The first case called for trial in that court was a suit for $50,000. Did the roofer's training qualify him to sit on a $50,000 case?

"I will not vote to convict that man if I stay here a million years," remarked one of the jurors in a criminal case before seats had been taken in the jury room. No headway could be made against his stand, and a disagreement was reported. Such a man lacks the open mind and is temperamentally unfit to serve on any jury.

Because of his training in accuracy and precision, the engineer is fitted to weigh evidence and discriminate between fact and fancy. There is hardly a case in either the civil or the criminal court in which the question of distance does not come up in some form. It is surprising what crude ideas the average witness has of distance. A suit for damages was brought by a man thrown from a wagon by reason of a depression in the street, which a contractor was alleged to have left after putting in a connection to a water main. It was important to know the depth of the depression. A number of witnesses testified to distances varying from 5 to 8 in. The last witness had measured the distance and found it barely 3 in. To the engineer on the jury the testimony of this witness outweighed that of the others. The plaintiff lost his suit.

A criminal case is fresh in mind where the first vote of 8 to 4 for acquittal was changed to a unanimous vote for conviction when an electrical engineer, who was a juryman, stated clearly and concisely his reasons for believing the defendant guilty. Subsequent events proved the verdict to be perfectly just.

A compliment was paid to the engineering profession by an able lawyer with a weak case. When he asked the men in the jury box their business, one replied, "Electrical engineer"; another, "Telephone engineer," and a third, "Civil engineer." These three, with a fourth man—the most intelligent-looking men in the box—were promptly excused from serving.

The engineer receives as well as gives in performing jury service. A jury of 12 men, all fellow citizens, usually represents a wide range of occupations and opinions. One thus gets new viewpoints and is broadened in his thinking.

*American Bridge Co., 30 Church St., New York City.

Lowering a Tunnel Under the Chicago River

SYNOPSIS—A street-railway tunnel on a steep grade has been lowered to clear new structures built over it. A flat roof was built under the old arch and side walls were put down to the new grade; then the inclosed core was excavated and the new floor put in. The river section of the tunnel was repaired at the same time. Concrete was placed by the pneumatic system and also by dump cars. All work was done inside the tunnel by company forces.

Alterations to the Van Buren St. tunnel under the Chicago River at Chicago, Ill., have involved difficult construction work of special interest. The tunnel is owned by the Chicago Railways Co., and carries a double-track street railway.

As originally built in 1889-90 (for cable traction) the tunnel had a concrete invert and a brick arch roof springing from the floor level, the tunnel being 30 ft. wide and 16 ft. high. In 1906 the tunnel was lowered 8 ft. to enable the river channel to be deepened. This was done by cutting niches in the walls to receive steel columns standing on the old arch footing and supporting transverse girders. Concrete jack arches were built between the girders, and when this new roof was completed the old arch above was destroyed and removed by dredging. New concrete side walls underpinning the footings were then built, and the bottom excavated to the grade of the new invert.

The tunnel as thus altered was 27½ ft. wide and 15 ft. high. On the approach inclines (with grades of 7% at the west and 11.5% at the east end) the brick arch roof remained in place, the sides being underpinned by concrete walls extending down to the new grade line. This reconstruction of the tunnel was described in *Engineering News* of Sept. 13, 1906, and March 7, 1907.

The construction of the new Union Station recently made necessary the lowering of the west approach to the tunnel, in order to clear the foundations of the new station. The change was complicated by the fact that the tunnel location was governed by two fixed points, one above the roof and the other beneath the floor. At the west line of the station property the tunnel had to be lowered sufficiently to pass beneath a baggage subway below the station tracks and platforms. About 250 ft. east of this the tunnel had to pass above one of the Chicago Tunnel Co.'s narrow-gage electric freight-railway tunnels.

The plan adopted was to drop the line from the street level at Clinton St. (the west end of the tunnel) on a descending grade of 11.345% to the east till clear of the station subway. This was followed with a grade of 0.5% until the freight tunnel was passed, and the line met the existing 7% grade of the old approach. The changes in grade are made by vertical curves of 1,400 ft. radius, with a length of 150 ft. for the upper and 80 ft. for the lower curve. The length of the open part of the west approach is reduced from 300 ft. to 167 ft. The old and new profiles are shown in Fig. 1.

Reconstruction of West Approach

The general plan of construction on the inclined portion west of the river tunnel was to build new side walls within the interior line of the tunnel, and to place upon this the new flat roof. This is shown in Fig. 2. The upper part of each wall was built and the new roof completed before any of the old tunnel was destroyed. This

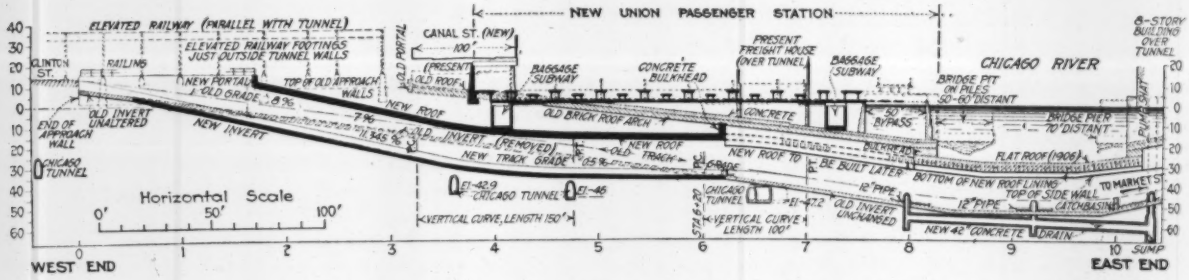


FIG. 1. PROFILE SHOWING ALTERATIONS TO THE VAN BUREN ST. TUNNEL OF THE CHICAGO RAILWAYS CO.

eliminated the necessity of bracing the old tunnel during the underpinning, as the new roof acted as transverse bracing for the old tunnel. In the old invert holes 12 in. deep were drilled, in which reinforcing rods for the new side walls were placed. On the old invert, inside the forms for the side walls, was laid a lapped floor of 1-in. boards, to prevent any bonding between the new wall and the old invert. Fig. 3 shows the reinforcement and form for the top section of the new side wall. The pipe is for the pneumatic concreting plant.

Where the new work was built against the old tunnel walls, the face of the wall was blasted away to give a roughened surface and to allow a thickness of at least 12 in. of concrete. In this new surface holes were drilled about 9 in. deep and 2 ft. c. to c. Hook bolts were wedged and grouted in the holes, and longitudinal reinforcing bars were laid upon these. The holes for blasting and for the hook rods were drilled with Sullivan air-tube rotary drills and piston hammer drills. The charge for each blast hole was about half a stick of 60% dynamite.

Across the top portions of the new walls were placed 26-in. steel plate girders 28 ft. long, spaced 3 ft. apart. A roof form was then built under the girders (sup-

ported on falsework) and concrete was filled in by the pneumatic system to form a flat roof 42 in. thick, in which the girders are embedded.

After the completion of this new roof a working drift about 6x6 ft. in the clear was driven along each side wall, just below the new roof wherever the clearance between the new roof and old invert was not sufficient for good working conditions. These drifts were timbered with old oak ties spaced 18 in. c. to c. and lagged with 2-in. plank, and were about 300 ft. long, being carried about 100 ft. farther west than demanded for clearance to facilitate the removal of the core.

From these drifts the lower side walls were constructed by underpinning the upper section of the side walls already built. Sections or chambers 10 ft. wide were excavated to the grade of the bottom of the walls. These were lagged and braced, after which the form was built to line, with 6x6-in. posts blocked against the adjacent core. Then the reinforcing steel was set, the 1-in. vertical rods being made fast to the ends of the rods in the upper walls by means of two cable clamps in a splice of 12-in. length. The concrete was placed from the pneumatic mixer, the bracing being removed as the chambers were filled.

The joint between the upper and lower sections of the wall was filled tight by grouting under a head of 10 ft. This was done by placing 2-in. pipes in position in the wall, and turning them up along the inside of the tunnel by means of a 90° elbow. A box was built around the top of the pipe and grout poured into this.

Fig. 4 is a view above the new roof. The men at the left are dumping a car of concrete into the form for the lower portion of the new side wall.

All underpinning sections were put in by following a prepared schedule which was kept in the engineer's office on the job. This schedule was arranged so that no section was put in adjacent to one already in place for at least seven days. New sections were kept as far away as possible from those in place, and at no time were sections directly opposite put in at the same time. These precautions were adopted to prevent settlement as much as possible. Some settlement was naturally expected, and as much as 8 in. occurred under Canal St. where the clay was soft. This settlement (which ran out in about 150 ft. each way from Canal St.) was the cause of leakage that occurred later in the new tunnel. This leakage was mostly stopped by grouting, and as the surrounding ground again compacts against the new walls it will in time undoubtedly cease.

In each of the vertical joints between the 10 ft. sections a 1-in. board was placed in the center of the wall, edgewise and parallel with the face of the new wall, so that half of the plank was in each of two adjacent sections. This was for the purpose of stopping leaks, it being expected that the wood would swell and tighten up in the joint. This method proved very satisfactory.

When the underpinning was entirely completed, the core between the walls was removed. Four sections were opened, working two alternately every other day, and sections 10 ft. in length were taken out. The 1-in. reinforcing bars for the invert were set by fastening them to the side-wall rods with two cable clamps at each end. Concrete for the invert was placed as soon as possible. The typical finished section of the western portion of the tunnel is shown in Fig. 5.

Along the 7% grade to the river, the old arch still forms the roof. At some later time a new flat roof similar to that already described will be built beneath this as shown in Fig. 1.

Reconstruction in River Tunnel

In the river section of the tunnel the bottom flanges of the steel girders and the supporting columns have been constantly exposed to moisture since they were placed in 1906, and were scaling badly. In order to protect the steel and to reduce the leakage, which was considerable, it was decided to build a concrete lining

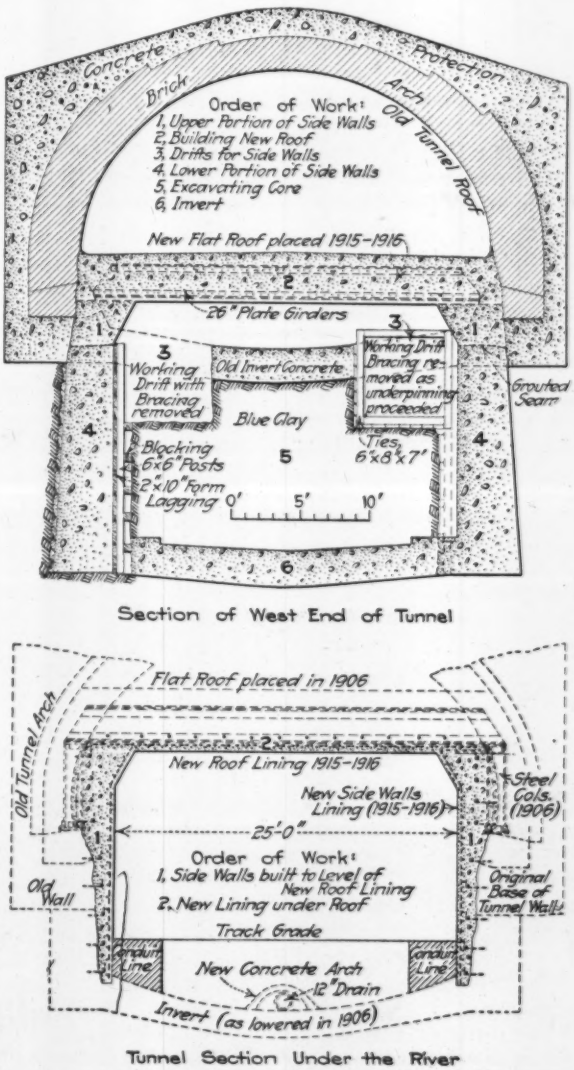


FIG. 2. SECTIONS SHOWING ALTERATIONS TO THE VAN BUREN ST. TUNNEL, CHICAGO

within the existing side walls and roof. The section adopted was the same as in the reconstructed west end of the tunnel. The new lining walls were extended 213 ft. east of the river section, to the old arch portal.

The method of reconstruction in the river section of the tunnel is shown by the lower drawing in Fig. 2. The work was carried out as follows: The faces of the old concrete side walls were blasted away to give at least 12 in. space from the line of the new facing. The brick-

work of the upper part (which was originally part of the old tunnel arch) and the faces of the concrete jack arches were roughened and clipped with a chisel attached to a pneumatic hammer. Hook bolts with longitudinal rods were then placed, as previously described. Then a rectangular reinforcement of ⅝-in. vertical bars and ⅜-in. horizontal bars was placed, this being 3 in. back from the new face line. The form was erected outside of this.

The side walls were then concreted to the height of the under side of the new roof protection, each side wall being completed for the entire length of the river section of the tunnel by continuous concreting. The concreting was done by hauling the mixed material in 1-yd. steel dump cars running on a track on an elevated runway alongside of the forms, and as close to the old roof as the dumping of the cars would permit. The runways extended from two ½-yd. electrically driven Ransome mixers placed inside of the tunnel.

The roof protection was constructed next. This is shown in Fig. 7. The old concrete of the jack arches was cut away along the lower flanges of the girders, and the exposed metal was scraped clean. Holes were drilled in the jack arches for hook bolts and for longitudinal 1-in. bars placed across the lower flanges of the girders. These were spaced 2 ft. c. to c., and staggered with the bars between the adjacent pairs of girders. The flanges were also wrapped with sheets of expanded metal. From the bars a reinforcement of ⅝-in. longitudinal and ½-in. transverse bars was hung by means of hooks.

The falsework for the roof forms was then built, about 4 in. clear beneath the flanges of the girders. The concrete was mixed by the two Ransome mixers in the tunnel and hauled under the forms. There it was dumped on platforms, from which it was cast into the forms by hand and rammed solid for every 3 ft., working between two of the roof girders from the walls to the center. The form lagging and longitudinal reinforcement were placed as the concreting progressed. The final keying up in the center was done by building the form tight and forcing grout under low pressure into the void. Numerous 2-in. grout pipes were placed in the roof, and later the entire roof of the river section was again grouted under pressure. Fig. 8 is a view in the completed tunnel, showing the bulkhead above the east end of the river portion of the tunnel.

The open portion of the west approach was entirely rebuilt. On the east side many of the sandstone block

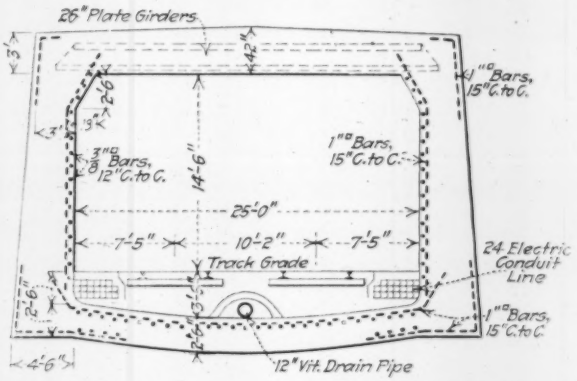


FIG. 5. TYPICAL SECTION OF WESTERN PORTION OF TUNNEL AS RECONSTRUCTED

of the masonry retaining walls had become badly disintegrated, and these were refaced with concrete. The disintegrated material was cut away, and a form built in front of the block, with a pipe extending to the top of the wall. Cement grout 1:2 was poured into the pipe, giving a head of 10 to 15 ft. on the form. The new surfaces are flat and the old joints are retained. After this work had been done, the entire surface of old stone and new concrete in this east open approach was given two coats of Trus-Con Stone-Tex waterproof paint.

Concreting and Grouting

Of the concrete west of station 6 + 20 (roof and side walls) about 5,000 cu.yd. was placed by the MacMichael pneumatic process. The mixer was of ⅓-yd. capacity, and the pressure was from 70 to 90 lb. The maximum distance for delivering the concrete was about 350 ft. For some parts of the work the delivery pipe had a hori-

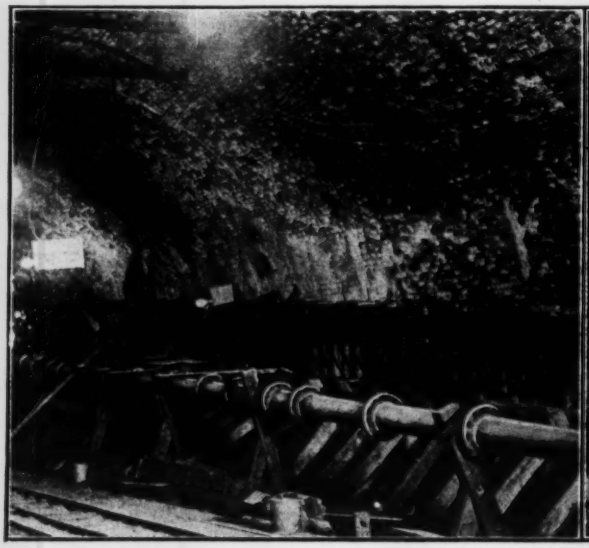


FIG. 3. BUILDING UPPER PART OF NEW CONCRETE SIDE WALL

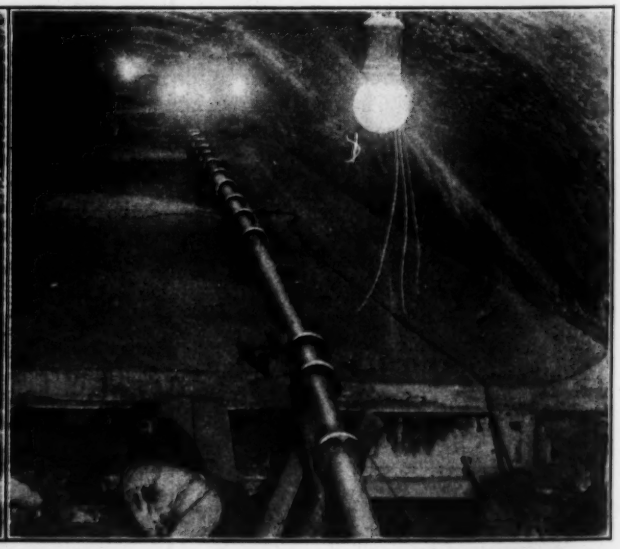


FIG. 4. NEW ROOF COMPLETED UNDER OLD ARCH

zontal curve of 180° followed by two of 45°, and a 90° discharge elbow into the forms. There was also a vertical rise of 35 ft. from the mixer to the form. For about 300 ft. of the invert, however, the concrete was mixed in the Ransome machines. These were used mainly in concreting the river section.

The concrete was a 1:2:4 mix, using stone with a maximum size of 1 in. for the pneumatically placed concrete, and ½ in. for that mixed in the usual way in the Ransome machines and distributed by the cars. In the concrete east of station 6 + 20, and in all the cement grouting, Ceresit waterproofing compound was added. No bituminous coating was used on top of the new roof.

FIG. 6. END OF NEW FLAT ROOF UNDER OLD ARCH ROOF
The space above the new roof is closed by a concrete bulkhead

Pipes for grouting were placed in advance of the concreting and after 60 days, when the concrete had had time to set, the cement grout was forced in under 80 to 90 lb. pressure. Where this grouting was near the old brick arch, a temporary centering was placed under the latter to prevent any danger of collapse. The grout was composed of equal parts of cement and powdered stone. Sand was not used when the grout was forced through the wall, as it was found that the cement and powdered stone would find a passage while the sand would be segregated and clog in the 2-in. grout hose. Three Ransome-Canniff grout mixers and one Cockburn mixer of the paddle type were used in the grouting.

The finished concrete surface of the roof and side walls was dressed with the Berg portable rotary surfacing machine. This consists of a disk driven at 2,000 r.p.m. and having in the face a number of hard-steel cutter wheels with toothed surfaces. These wheels roll on the surface and chip off any fins or board marks. The operator carries a small motor slung on his shoulder, and this is connected to the surfacing device by a flexible shaft.

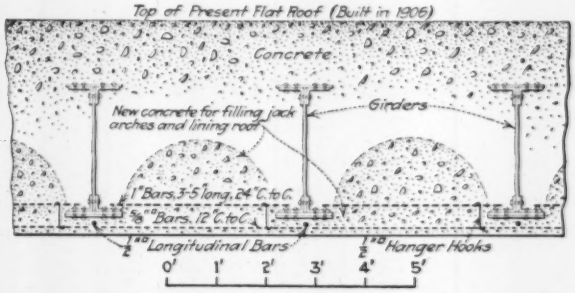


FIG. 7. REINFORCING OF THE OLD ROOF IN RIVER SECTION OF TUNNEL

The 8-in. delivery pipe used for conveying concrete from the pneumatic mixer to the forms was taken from recently abandoned power houses, where it had been in service for something over 20 years. It was mostly extra heavy pipe and was not the best suited for the work, but was used in order to save the expense of purchasing the necessary new pipe.

Handling Materials and Power Cables

The roof girders were 28 ft. long, and weighed 4,300 lb. each. There were 142 of these to be placed, and their location and elevation were determined by small concrete pedestals formed on top of the new side walls.

FIG. 8. COMPLETED TUNNEL AT EAST END OF RIVER SECTION, WITH BULKHEAD OVER NEW ROOF

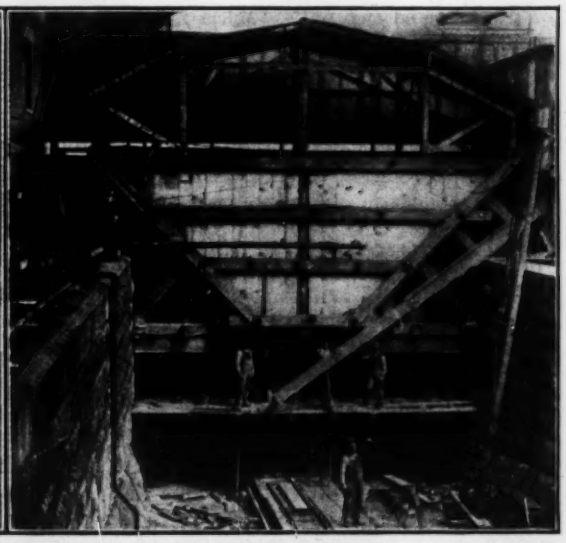


FIG. 9. CONCRETE MATERIAL BINS AT WEST PORTAL OF TUNNEL

FIG. 10. HANDLING 28-FT. PLATE GIRDERS IN THE TUNNEL WITH AN ELECTRIC DERRICK CAR

For handling these girders an old motor car was converted into an electric derrick car, and a temporary standard-gage track was laid in the new part of the tunnel for the derrick car in handling and placing the girders. Fig. 10 shows this car placing one of the girders.

The railway tunnel carries about 30 large cables for power supply to the business district, and these had to be kept in operation during the work. They were placed originally in conduits at either side of the tunnel, but were shifted temporarily to a wood box in the center of the floor. This box was of heavy construction, to protect the cables and the work, and the narrow-gage track was laid upon it.

The cables remained in this position during the work on the roof and side walls. When the reconstruction of the floor was undertaken the cables were attached to timbers bolted temporarily to the new roof in the tunnel, and to slotted vertical posts bolted to the side walls of the open approach.

In the completed tunnel the cables are placed in conduits at either side of the track. These are covered with concrete and form sidewalks, manholes being provided at intervals. The cables were cut and spliced twice, and shifted five times, during the progress of the work.

Tracks, Drainage and Other Work

The tunnel tracks were laid with 100-lb. T-rails welded together. These were cut into lengths of 350 ft. and hauled out on the east approach until the work was finished. Then they were hauled back, relaid and welded.

The river section of the tunnel as altered in 1906 had an 18-in. tile sewer below the invert and leading from a sump in the invert to a pump shaft at the east end. This sewer was found to be nearly stopped up. A 42-in. concrete sewer was built, therefore, beneath the invert, with a sump in the center and at each end, and a drain from the east sump to the pump shaft. The material beneath the tunnel was found to be so hard that blasting was required in excavating for the sewer. Drainage of the tunnel is provided for by a 12-in. vitrified pipe laid on the invert and covered with a segmental concrete arch over which the track ballast is filled.

Force and Management

During the main part of the work, the force worked three 8-hr. shifts daily. The work was all done by company forces, as it was not well adapted for letting by contract, and the presence of the live cables would have been a hazard for men not accustomed to electric railway work. The tunnel was closed to traffic in June, 1915, and reopened in May, 1916. The work was designed and executed under the direction of John Z. Murphy, Electrical Engineer of the Chicago Surface Lines; J. W. Harris was Tunnel Engineer; Roy W. Emmert was Assistant Engineer and John J. Casey, Superintendent.

Activated-Sludge Experiments at University of Illinois

By Edward Bartow, F. W. Mohlman and J. F. Schnellbach*

The first series of activated-sludge experiments at the University of Illinois, begun Nov. 1, 1914 (*Engineering News*, Vol. 73, p. 648, 1915) was constructed in 3-gal. bottles. The second series was conducted in a tank 9 in. square and 4½ ft. deep. The third series was conducted in four tanks each having an area of 10 sq.ft. and a depth of 9 ft. (*Engineering News*, Vol. 74, pp. 166, 1096, 1915). Experiments in the first three series were carried on by the fill-and-draw plan. At present, for the fourth

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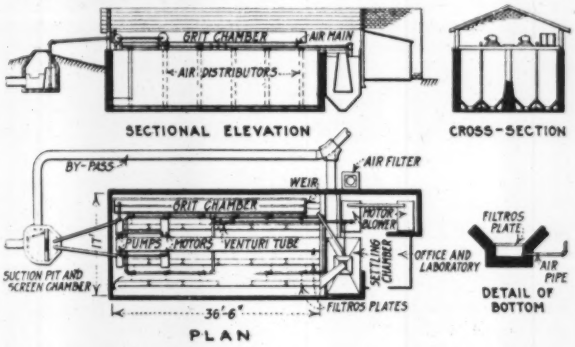
series, a continuous-flow plant is being successfully operated. This series is conducted in the septic tank designed by Prof. A. N. Talbot (*Engineering News*, Vol. 42, p. 111, 1899) in 1897 for the City of Champaign. Early in 1916 this tank was placed at the disposal of the State Water Survey, and was reconstructed with the expectation that 200,000 gal. of domestic sewage be treated daily.

Design of Plant

The plant (see accompanying illustration) contains a screen chamber and pump pit, a grit chamber, an aëration chamber, a settling chamber, a blower room and a laboratory. A sludge-drying bed and a pond into which the effluent from the process may be discharged are also provided. Plans have been made for the installation of sludge-drying apparatus.

The sewage is drawn from the main outlet sewer of the City of Champaign. The daily flow is from 1,000,000 to 1,500,000 gal. The manhole nearest the septic tank was modified to serve as a screen chamber and suction pit for the pumps. A weir was placed in the outlet to raise the sewage level and provide suction for the pumps. Vertical bars spaced with ¾-in. openings prevent coarse material from reaching the suction of the pumps. The sewage is pumped to a grit chamber by two centrifugal



ACTIVATED-SLUDGE PLANT DETAILS, CHAMPAIGN, ILL.

pumps, one with a capacity of 75 and the other of 110 gal. per min. Each pump is belt-connected to a 3-hp. electric motor. The grit chamber is 34 ft. long, having two compartments each 1 ft. wide. At the outlet is an adjustable weir through which the sewage must flow and where its rate can be measured.

The sewage flows from the grit chamber into the aëration chamber, a rectangular concrete tank 17x36½ ft. in plan and 9½ ft. deep, having a capacity, after allowances are made for the baffle walls and the sloping bottoms, of about 36,000 gal. The chamber is divided longitudinally by three baffles into four compartments through which the sewage travels a distance of about 140 ft. The lower part of each compartment has sides sloping toward the center, to a channel 10½ in. wide and 4 in. deep, extending lengthwise through the tank. Above this channel filtros plates are supported on T-bars that have been embedded in the concrete. The channel below the filtros plates was divided into sections for six filtros plates with the expectation that each set of plates would be separated from all the others and that the supply of the air to the plates could be regulated by an air pipe and valve for each set. Owing to the porosity of the sloping concrete sides it has been found impossible to regulate independently each set of plates. The aëration tank should be capable of treating 144,000 gal. of sewage and sludge per day if aërated during a period of 6 hr.; 170,000 gal. if aërated 5 hr., 216,000 gal. if aërated 4 hr.

The treated sewage and sludge flows from the aëration chamber to the settling chamber. The settling chamber is 6x10½ ft. in plan and 10½ ft. deep at the lowest point. It has a capacity of 3,700 gal. This would give a retention period of 24, 31 and 37 min. with a flow of 4, 5 and 6 hr. respectively, through the aëration chamber.

In order to assist the settling of the sludge, the liquid is passed down through the center and up around the edges of a hollow wooden pyramid placed in the center of the settling basin. The pyramid is 15 in. square at the top, 3 ft. square at the bottom and extends to within 3½ ft. of the bottom of the chamber.

From the settling tank the effluent flows over a weir to the creek or into the pond. The pond is formed by two dams placed across the abandoned bed of a small stream. It covers about 0.1 acre and is 3 ft. deep in the deepest part.

The sludge is withdrawn from the settling chamber by an air lift and can be discharged into the raw sewage where it enters the aëration chamber, or can be diverted for experimental purposes, or to the sewer. Some sludge has been dried on a sand bed having an area of 256 sq.ft. and a depth of 8 in. The drying of sludge on the sand bed is not considered a success.

Air is supplied for aëration and for the air-lift by a rotary positive-pressure blower having a rated capacity of 300 cu.ft. per min., driven by a 15-hp. electric motor. The air is filtered through cheese cloth spread over a wire box before it enters the blower suction pipe. The air is measured through a venturi meter.

Performance of Plant

The plant has been in continuous operation for twelve weeks (on Oct. 4, 1916) prior to which time it was operated intermittently for periods of from one to three weeks. No special effort was necessary to build up activated sludge. The plant has simply been put into operation, allowing the effluent from the settling chamber to escape while pumping back the sediment. From the start 90% of the suspended matter was removed and after 13 days of operation stable effluents were obtained.

The results achieved have been very gratifying. Purification is indicated by the presence of from 5 to 8 parts per 1,000,000 of dissolved oxygen and the stability to methylene blue of from 5 to 15 days. The effluent is odorless and generally clear though at times, because of the insufficent capacity of the settling chamber, it contains small particles of sludge.

The plant has been run to obtain a clear effluent. Owing to the insufficient size of the settling chamber the actual rate of operation has been less than one-half of its rated capacity. Additional settling chambers are to be installed.

After satisfying ourselves that the plant could be run satisfactorily at a rate suitable to the capacity of the settling chamber, the rate has been increased to 150,000 gal. per day even though some sludge escapes with the effluent. At this increased rate, using 2 cu.ft. of air per gallon of sewage, stable effluents have usually been obtained. Owing to the presence of sludge in the effluent, the effluent was allowed to settle in glass cylinders 30 min. longer before taking samples for analysis.

Sensitive Water-Level Recorder

By E. J. Hoff*

After unsuccessfully searching the markets for instruments of a type sensitive enough to record minute variations of the water level in evaporation experiments, the Irrigation Investigations branch of the United States Office of Public Roads and Rural Engineering undertook to provide its own instruments to meet the requirements. This "evaporimeter" was planned to record continuously and accurately the lowering of a water surface by evaporation to 0.01 in.

The method adopted is to use a reasonably large evaporation tank of sheet iron about 6 to 8 ft. in diameter, and some few feet from it a small float tank of a diameter not less than 3 in. larger than the float. The tanks are connected near the bottoms by a small pipe. They are placed with the rims at ground level, as shown in Fig. 1.

The float tank is especially protected against evaporation by a cover that has but a small hole for the float wire to pass through. Hence, we can assume, in case the float tank is very small and the evaporation tank large, $E = E' + \frac{sE'}{l}$, when E is the true evaporation, E' the recorded evaporation, s the float-tank area, and l the evaporation-tank area.

If this relation of tanks does not exist, it will be wise to determine (by means of hook-gages) the evaporation losses in both tanks separately, when the communication pipe is closed. This also will demonstrate the influence

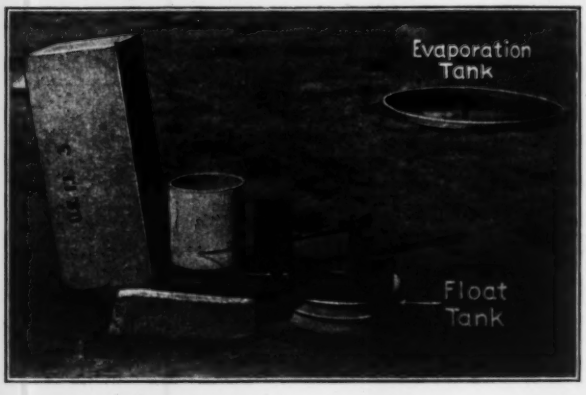


FIG. 1. "EVAPORIMETER," IRRIGATION INVESTIGATIONS, U. S. OFFICE OF PUBLIC ROADS AND RURAL ENGINEER

of heat-conducting metal floats upon the water that is not exposed to the air. To eliminate this latter factor a glass bottle might be used for the float.

The evaporimeter resembles the usual type of recording instrument. A large clock-driven cylinder is provided to carry an 8x24-in. record sheet, and a lever connected with a float by a fine brass wire transmits the float motion to a pen placed at the end of a long pen-arm. The pen-point movement is ten times that of the float.

A pressure on the pen required to accomplish continuous recording would put a heavy load upon the float, which in consequence could not move gradually as the water does—the record of which we want. To eliminate this serious objection an additional arrangement is provided, which we call the rocker-arm.

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The duty of this rocker-arm is to move the pen-arm from its normal position, in which the pen does not touch the record sheet, toward the cylinder at regular intervals. For this purpose the rocker-arm is connected to the clock by cams and levers. Every five minutes the rocker-arm moves the pen against the paper, where it makes a dash as the cylinder moves. When the rocker-arm's motion is reversed, the pen-arm returns to its normal position, but the rocker-arm retreats still farther, leaving the pen-arm free.

By means of the rocker-arm we have introduced two periods: One when the rocker-arm engages the pen-arm

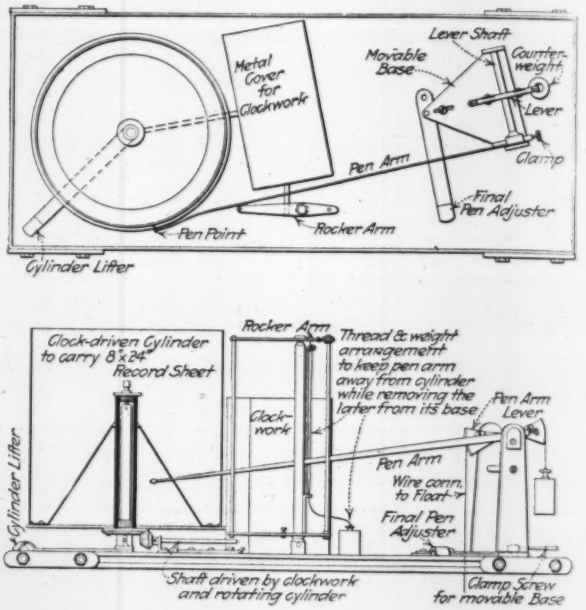

FIG. 2. DETAILS OF "EVAPORIMETER," WHICH RECORDS VARIATIONS OF WATER LEVEL TO 0.01 IN.

and causes the pen to record; and the other when the pen-arm is left in its normal position entirely free, subject only to the float's action. The records indicate the gradual lowering of the water surface and show precisely when extraordinary changes in water level occur.

The only remaining friction consists of the pressure (exerted upon highly polished pivots of small diameter) by the combined weight of the lever, pen-arm and double counterweight, all of which have been reduced to a minimum; therefore, the friction may be considered negligible. The employment of knife-edge bearings might have reduced this factor, but for practical reasons the pivot bearings are preferable.

For convenience and ease in operation several provisions are made. The record-sheet holder is a slit metal cylinder, which by its own elasticity or spring holds the record sheet. The cylinder is centered upon a platform that is especially mounted upon a point bearing about 5 in. above its base, thus securing the most stable support and the one easiest moved by the clock to which it is connected through a train of gears. The cylinder makes one revolution every 12 hr., or moves 2 in. per hr.

When the mounted record sheet is placed upon the platform, it can be disengaged from the gears and clock in order to allow free rotation, which is necessary for time setting. When the proper time as marked on the record sheet is near the pen point, a lever or cylinder

lifter at the base of the cylinder is moved toward the left, which lowers the platform and engages the gears. A finer and final setting is made by adjusting the base of the lever by means of a clamp and slow-motion device.

While the preparatory work is going on, the pen is not in the operator's way, for it is not wise to disturb the lever and float. A spring is attached to the rocker-arm support, which by means of a small weight draws the pen-arm away from the cylinder, thus clearing the field for the operator. After setting, the weight is lifted and placed upon the instrument base, and the pen-arm resumes its normal position.

According to reports, this instrument has given satisfaction in every detail, and we seem justified in looking forward to a successful solution of a very difficult problem.

Method of Making Drainage and Improvement Assessments

By Percy A. Cupper*

A board of appraisers assessing benefits and damages in drainage or other improvement districts has a thankless job, and unless guided by past experience and good judgment the appraisal is apt to result in a hopeless muddle. Even under favorable conditions an appraisal of this nature is on a par with judging a baby show. Discretion is the better part of valor, and escape before the result is announced is the only safe course.

Most of our drainage statutes provide for an assessment of both benefits and damages and also provide that if the damages, which include the cost of the works, are in excess of the benefits to be derived the improvement shall not be made. This makes it necessary in addition to securing an estimate of cost and assessment of damages to fix also the amount that the improvement will be worth. It is practically impossible to view one tract after another and fix in dollars and cents the proportional part of the total cost that each tract should bear, and almost endless adjustments are sure to result. The use of abstract figures eliminates much of the difficulty.

Factors To Be Taken Into Consideration

There are many factors to be taken into consideration in fixing the benefits to be derived by any particular tract of land from the improvement: Its condition prior to improvement, or the extent to which it requires improvement; its location; the productivity of its soil; its topography, elevation, accessibility—all of which may be expressed by the value of the land after improvement.

For example, one tract of land in a proposed drainage district may be already 50% drained and producing, while another tract may be marshy and valueless. While both may be of equal value when drained, the drainage would be worth twice as much to the second tract as to the first. Again, consider the result if the first tract when drained should, on account of its soil condition, location, etc., be worth twice as much as the second when drained. It is obvious that the relative advantage accruing to the owners of the two tracts would be as 4 to 1.

So it may be said that the benefits—the increased productive value of the land—may properly be considered under two heads: First, the relative condition of the land before and after drainage and, second, the value of the land after drainage. By using abstract numbers to represent these two elements that go to make up the benefits and by taking the acre as the unit the relative amount that should be assessed against each tract is easily determined. If we fix 100% as the maximum improvement and maximum increase in value due to drainage, then the product of these factors gives the percentage of maximum acre benefit to be assessed against the tract. The damages may be estimated directly, as the amount of damage is not fixed, as is the total amount to be raised. As a basis for further discussion the accompanying tabulation is submitted.

Explanation of Tabulation

The area in column 3 should include only the acreage in the tract that will be benefited. In column 4 is given the percentage of maximum benefit per acre. Valueless marshy land would receive the maximum benefit and would be marked 100% under this column, while land under cultivation, though requiring some drainage, would receive less benefit and would be marked correspondingly less. The same is true of the percentages of maximum value in column 5.

If two tracts of land are in the same condition relative to drainage requirement, yet after drainage one tract is worth twice as much per acre as the other, it is obvious that one receives twice as much benefit per acre as the other. By taking the product of the percentage of maximum improvement and of maximum value (columns 4 and 5) we get what may be termed the percentage of maximum benefit per acre (column 6); and if this is multiplied by the number of acres in the tract, we get a corresponding figure for the tract, column 7.

In the tabulation the amount of money to be raised by assessment is $6,494, and the damages amount to $220, making a total of $6,714, which amount must be taken into account in fixing the sum each tract shall be assessed. The figures in column 7 represent the proportion each tract shall bear, and by dividing the sum of these figures—namely, 236.2—into $6,714, the gross amount

*Assistant State Engineer, Salem, Ore.

FORM FOR USE IN MAKING ASSESSMENTS OF BENEFITS AND DAMAGES FOR IMPROVEMENTS*

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Name	Land Description	Area in Acres	% of Maximum Improvement	% of Maximum Value	Product of Columns 4 and 5	Product of Columns 3 and 6	Gross Assessment	Net Assessment	Net Benefit	Acres Damaged	Value	Other Damage	Total Damage
J. N. Brown....	NW¼NE¼ 30-19-23...	38	100	90	90	34.2	$972.14	$952.14	$1,690	2	$15	$5	$20
E. R. Wilson...	E½NW¼ Sec. 5.... ..	75	80	75	60	45.0	1,279.13	1,199.13	2,170	5	55	25	80
C. J. Evans....	NE¼ Sec. 6.....	155	90	80	72	111.6	3,172.23	3,122.23	5,530	5	50	..	50
C. J. Evans....	NW¼NW¼ Sec. 5....	20	100	100	100	20.0	568.50	548.50	980	2	20	..	20
S. V. Lent.....	SW¼NW¼ Sec. 5.....	40	60	50	30	12.0	341.10	341.10	60¢	..	...	...	....
L. H. Mun.....N½NW¼ Sec. 6.....		56	30	80	24	13.4	380.90	330.90	622	1	30	20	50
Totals		384	...	...	...	236.2	$6,714.00	$6,494.00	$11,592	15	$170	$50	$220

*Amount of money to be raised by assessment, $6,494; estimated maximum benefit per acre, $50; factor (28.425) obtained by dividing sum of figures in column 7 into amount of assessment plus damages.

involved, the quotient is 28.425. Now if each number in column 7 is multiplied by this quotient, the result is the gross assessment against each tract, as shown in column 8. After deducting the damages the net assessment is given in column 9.

In order to determine the benefits the appraisers should fix the maximum benefit per acre that will accrue to any tract in the district. In the tabulation this has been fixed at $50 per acre. On this assumption, by multiplying the figures in column 7 by 50 the result is the gross benefit, and by deducting the damages we get the net benefits, as shown in column 10. It is then seen at a glance that the net benefit is $11,592 and exceeds the cost plus damages by $6,714—a fact that is necessary to establish in the financing of most drainage districts. A certain area of land is rendered valueless for agricultural purposes by the construction of ditches, etc., and it is upon this area that damages are assessed, as shown in column 11. The total damage from this source is given in column 12, while any other damages, as for example, inconvenience due to the construction of a large ditch, may be listed in column 13 and the total damage in column 14.

It must be borne in mind that most of the columns in this tabulation are to facilitate computations, only a very limited number being for recording field observations. The advantage in this general plan of assessment lies in the fact that the proper proportion is assessed against each tract without considering it in money, and the total assessment is bound to equal the amount to be raised.

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Cable Inclines on the Sao Paulo Ry. in Brazil

By F. A. Molitor*

The Sao Paulo Ry., in Brazil, although only 86 mi. in length, is one of the most notable railways of South America. Its engineering features are of particular interest because it makes the ascent of the abrupt slope of the mountain range known as the Serra do Mar by a cable incline. Sao Paulo is on a high plateau at an elevation of 2,000 to 3,000 ft. above sea level. The maintenance-of-way conditions, due to the steep sidehill location of the main part of the line, deserve special attention by American engineers. Part of the information given below was obtained by the writer during a study of the railway systems of Brazil.

The railway is a double-track line with a gage of 1.6 meter (5 ft. 3 in.). It runs from the port of Santos to Sao Paulo, 79 km. (49 mi.), and Jundiahy, 139 km. (86 mi.). In spite of this small mileage it enjoys the distinction of being one of the most profitable railways in the world. In 1913 its gross earnings were equal to $136,000 per mi., and as the operating ratio was 65.8% the net earnings were $46,400 per mi. This includes a liberal allowance for maintenance: $21,220 per mi. upon the track and $18,600 per mi. upon equipment. A map of the railway and its connections is shown in Fig. 1.

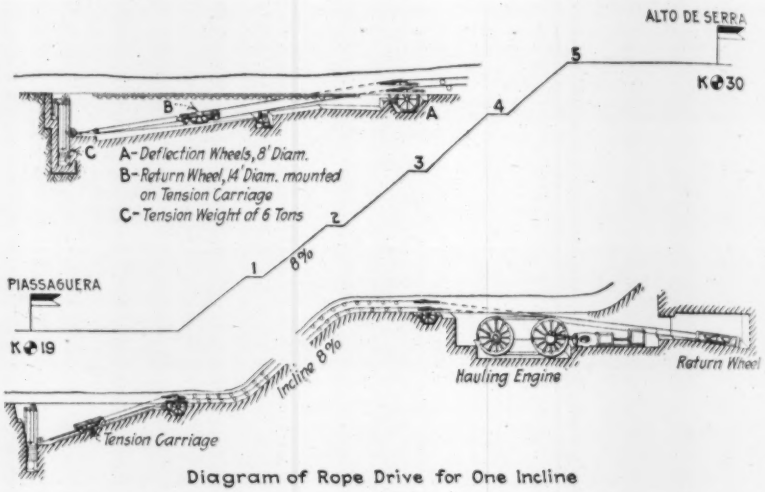

FIG. 2. PROFILE OF THE CABLE INCLINES OF THE SAO PAULO RY. AND DIAGRAMS OF THE CABLE MACHINERY

The railway was opened in 1867, the ascent of the Serra, or range, being by four inclines of 10% grade worked by rope haulage on the "tail-end" system. The duplication of the entire line was commenced in 1895 and completed in 1901. For the steep ascent a new route was chosen, with five inclines of 8% grade, also worked by rope haulage on the "tail-end" system. The old line is kept in condition for use in case of trouble and for aid during the heavy coffee traffic movement.

The railway is divided into three distinct sections. The first section, from Santos to the foot of the range, 19 km. (11¾ mi.) is practically flat, on marshy ground, and is operated by locomotives in the usual way. The second section overcomes the great difference of level which has to be surmounted to reach the high table-land. A rise of 2,600 ft. is accomplished in a distance of 10 km. (6.2 mi.), which necessitates a ruling grade of 8% from the base of the slope to its summit. The third section extends from the top of the inclines, at 30 km., to Sao Paulo and Jundiahy. It is operated in the usual manner.

At Piassaguera (at the foot of the incline) the locomotive is cut off and the cars are moved to the foot of the first incline. Each incline is operated independently, and has a cable composed of six strands of steel wire on a hemp core. This has a breaking strength of 108 tons when new and 72 tons when worn, and as the maximum working load on the cable from all sources is 18 tons, the

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FIG. 1. MAP OF THE SAO PAULO RY. (BRAZIL) AND CONNECTING RAILWAYS

factor of safety varies from 4 to 6. The cable is supported and guided on the inclines by small wheels placed between the rails, and at the bottom it enters an underground chamber where the tension carriage is located, as shown in the profile, Fig. 2.

The track on the inclines has 103-lb. T-rails (46.2 kg. per meter). In order to suit the relative paths of the up and down sides of the rope the track is formed of three rails, except that at the passing places and heads of the inclines two separate tracks are laid to permit trains to pass. A grip car attached to the train has mechanism for picking up and gripping the cable, which is driven by a stationary engine placed at the top of the incline. This car has also powerful brakes, including a track brake.

The five inclines, each with its separate hauling plant, work simultaneously; that is, there are always five trains ascending and five descending when the inclines are working, the vehicles on one side of the cable being balanced by those on the other side. The paying load may or may not be equal in both trains. The average unbalanced load is small and the larger load moves down the incline.

The winding engines, each of approximately 1,000 hp., are of the two-cylinder condensing type. The cylinders are 32x60 in., fitted with Corliss valves operated by the

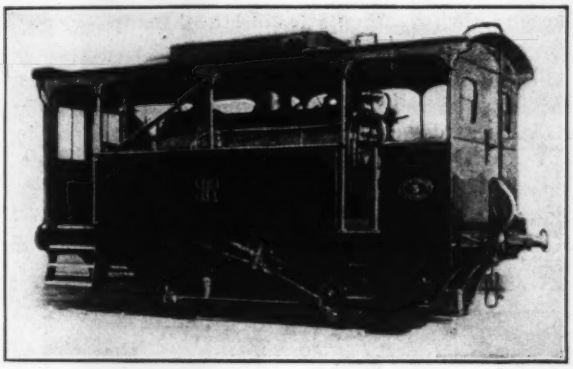

FIG. 3. GRIP CAR FOR THE CABLE INCLINES OF THE SAO PAULO RY. (BRAZIL)

Gooch link valve-gear and a special trip gear. Each power station has four Lancashire boilers 7½ ft. diameter and 27 ft. long. They have the Vicars stoker and Green economizer, and supply steam at 100 lb. pressure.

There are two parallel shafts carrying cable drums and 25-ft. flywheels, the latter connected by a rope-drive of 16 cotton ropes, so that both the crankshaft and second shaft are driven by the engine. The cable entering the engine house from the up line makes four turns around the drums, passes to a 14-ft. horizontal reversing sheave, and thence out to the down line.

The maximum weight of train which can be hauled on the inclines is 145 tons; this train is composed of six loaded cars weighing 114 tons and the grip car which weighs 31 tons. Of this weight 78 tons is paying load. The time necessary to run a trip is eight minutes, so that 7½ trips can be run in an hour. This means that 585 tons per hour can be delivered at the top and at the bottom of the inclines, and in ten hours over 5,000 tons of merchandise can be handled in each direction.

With the endless-rope incline system the dead load is always balanced, the ascending train on one side being balanced by a similar train on the descending side. The duty of the stationary engine is to overcome the excess or unbalanced load, whether arising merely from friction or from difference in the weight of the two trains. The speed of the trains is controlled by the brakes on the hauling engine. A train may be run on only one side of the rope, as there is a constant tension caused by the tension weight. In this case the unbalanced load is the total weight of the train.

Special devices are applied to prevent trains becoming detached from the rope. The entire rolling stock is fitted with the quick-acting vacuum brake, which (with the rail grip on the grip car) provides ample power to hold a train should it become detached.

The maintenance expenses have been criticized as being very high. Every care must be taken, however, to prevent slides on the mountain, and as the formation is treacherous it is good practice to carefully pave wherever the original surface of the ground has been disturbed, or where there is any chance of water eroding it. The long experience of the English engineers upon this mountain line, and their national training in well-maintained railways at home, has prompted them to special care in the details on this difficult line, and with satisfactory results. Certainly the results of operation with a heavy business speak well for it. Both the technical and physical conditions of the property are good.

The length of double-track main line is 86 mi., and sidings aggregate 113 mi. Tangents represent 58% and curves 42% of the length; while 76% is on grades and 24% is level. The maximum grade (exclusive of the inclines) is 2%, and the sharpest curves are of about 7°. There are 16 bridges, some of masonry and others of steel, aggregating about 4,600 ft. and having spans of 33 to 250 ft. The 13 tunnels are 200 to 850 ft. long, and aggregate 4,430 ft.

The original cost of the line was about $43,000,000, or $497,000 per mi. (U. S. currency). The original concession provided a guarantee of 7%, which was paid by the government, between 1867 and 1873, in the amount of about $2,600,000. In 1874 the guarantee ceased and the company commenced to divide with the government (in accordance with the concession) the net earnings in excess of 8%, and up to 1890 it had paid the government about $4,672,000. The company is now independent of the government except in respect to operating and traffic regulations.

In 1912 (no later records are available) the railway carried 2,968,810 passengers, with an average haul of 23.4 mi. The freight handled was 2,737,820 tons.

A Change in the Channel of the Mississippi River at St. Paul was urged by the St. Paul Commercial Club in a recent hearing before a board of Army Engineers. The club proposes to follow out the general plan prepared by Lieutenant-Colonel Shunk, of the Corps of Engineers, diverting the river as far as possible toward the west-side bluffs and utilizing as a harbor for water traffic the east end of the old channel not filled, so far as it is not required for railway terminals. The project is based also on a report as to the commercial needs presented by M. G. Barnes, Consulting Engineer. The total cost of the improvement is estimated at $4,935,000, which may be raised to $5,600,000 by a possible increase in certain items. Some of the possible sources for providing the funds to carry out the improvement are, first, a Federal appropriation; second, an assessment upon property specially benefited, and third, the proceeds of the sale or rental of the lands reclaimed by filling in the old channel. It is claimed that about 180 acres of this new land, lying near the present railway terminals, could be sold at a price sufficient to pay the entire cost of the improvement.

Monolithic Brick Paving for Wide Streets

By William Robert Paige*

SYNOPSIS—A special feature of the work described is the use of a novel type of expansion joint and the laying of bricks in header courses on each side of these joints. The bricks are laid on a 4-in. base of green concrete, no sand cushion being employed.

A monolithic brick pavement 33 ft. wide is being constructed by the writer on Main St. at Marshall, Ill., a city of about 5,000 inhabitants. Main St. is a part of the old National Road from Cumberland, Md., to St. Louis, Mo., and is 100 ft. wide, 20 ft. having been added to the original width when the town of Marshall was platted. Six years ago, four blocks of this street through the business section were paved by the writer with brick on a sand cushion and concrete base. The roadway is 60 ft. between curb lines (with 9-in. crown) and 57 ft. between gutter lines, a combined curb and gutter being used. This paving is in excellent condition.

It was decided last spring to extend this pavement east and west to the city limits. The first plans submitted called for a boulevard having a 20-ft. parkway through the center, with a 20-ft. drive on each side and a 20-ft. space for parkway and sidewalk on each side of the road. This made the curb lines of the new proposed paving continuous with the curb lines of the 60-ft. roadway and would have divided the street into five equal parts. The expense, however, was found to be greater than the property owners felt they could afford, and the boulevard idea was abandoned. A central roadway 36 ft. in width was substituted, the combined curb and gutter making the actual width of the brick roadway 33 ft.

The monolithic type of brick pavement (in which the bricks are laid directly upon the green concrete) had been used successfully on highways having narrow widths, and the writer believed that the same type could be successfully used in wide streets by following somewhat different methods. The combined curb and gutter was first constructed along each side of the roadway. Then the excavations were made, first the rough and then the finishing grading, using a templet to shape the subgrade accurately, which was then rolled with a steam roller.

The concrete is mixed in a portable batch-mixing machine, with a boom and traveling bucket for placing

*Civil and Consulting Engineer, Terre Haute, Ind.

FIG. 1. MONOLITHIC BRICK PAVING ON WIDE STREETS AT MARSHALL, ILL.

A—Finishing the concrete base with templet. B—Brick laid, showing expansion joints. C—Expansion joints with header bricks. D—Lug bricks laid and ready for cement filler

the concrete. The concrete is spread out uniformly to a slightly greater depth than that required, and a Roughen templet is drawn over it several times to obtain a true surface of uniform depth.

The contractor was instructed before commencing the work to obtain a templet that would be as nearly rigid as possible. In order to prevent the templet from rolling over the concrete, three men ride it, one in the middle and one on each side. The templet rolls on wheels on the concrete gutter and has a contrivance for raising it when running back over the concrete for the next drag. The templet is pulled by hand by the mixing crew, while the engineman moves the mixer forward. The pulling is done with five ropes—at the center, the quarter-points and the ends.

After the concrete has been properly shaped (which sometimes requires five or six drags), the templet is again drawn back and a mortar cushion spread in front of it by shovels. The templet is drawn over this without changing its height, forcing the mortar into the voids of the concrete. This operation is repeated until the surface presents a true surface for laying the brick, as shown at *A* in Fig. 1. A man with a hand tool corrects any irregularities.

The surface is then ready for the bricklayers. The carriers deliver the brick by walking on boards placed over the brick already laid, the boards being moved forward as the laying progresses. The brick are sorted outside of the pavement, an attempt being made to have the correct face of the brick up, but owing to the haste of the men this is only partially accomplished. A man placing bats keeps the rows completed, and a sweeper cleans the pavement so that the inspector can readily go over the surface. The brick are quickly turned and culled and are immediately rolled with a hand roller weighing approximately 900 lb.

Occasionally a brick fails to go down to its proper place and is driven by hand with a wooden tamp. Water is also sometimes used to assist in the proper rolling. The brick are then grouted with a cement filler, the usual methods being pursued. The paving is of Dunn wire-cut-lug brick manufactured at Albion, Ill. This construction requires a brick to be very uniform in size. At *D* in Fig. 1 is shown the joints between the brick, ready for filler, the joints being open to the full depth of the brick.

Street intersections, where the templet cannot be used, are put in by hand, stakes being set at intervals sufficient to give the proper cross-section. The mortar cushion is shaped by hand tools, and while it is not possible to secure as accurate shaping of the concrete and mortar cushion as where the templet is used, the results are entirely satisfactory. The total amount of work to be done under the present contract is 15,060 sq.yd. of 33-ft. width, 5,130 sq.yd. of 25-ft. and 3,320 sq.yd. of 20-ft. width. The 20-ft. width is for alleys.

The base is 4 in. thick, with 3¾ in. of concrete and ¼ in. of mortar cushion. The concrete is a 1:6 mix, using bank gravel. The mortar cushion is 1:2, using clean sharp sand. The grout filler is mixed 1:1. The mortar top is mixed in boxes by hand, but a small batch mixer would be very advantageous for this part of the work.

Prepared asphalt expansion joints 1 in. thick are used between the brick and the gutter, and two transverse expansion joints 1 in. thick are used in each block, approximately 165 ft. apart. Joints are provided between the concrete base and the gutter by means of a 1x4-in. board, which is removed after the concrete is placed and shaped, and the space then filled with sand. Transverse joints are made through the concrete by cutting with a spade after the brick are laid up to the place where the joint is required. This cut is filled with sand and the concrete tamped into position.

The transverse joint has a special feature that is original with the writer. When the location of the joint is made, a trench 2 ft. wide (12 in. on each side of the location) is cut to a depth of 3 in. This trench is filled level full with concrete and covered with building paper. The concrete base is then placed and shaped over this support. The joint is afterward cut through to the paper and filled with sand, as above described, care being taken not to break the paper. This gives a solid base for the joint to rest upon, and on which it may freely move. This prevents settling of the base, which might be caused from water seeping through and softening the subgrade at these joints. Fig. 2 shows the construction of this joint.

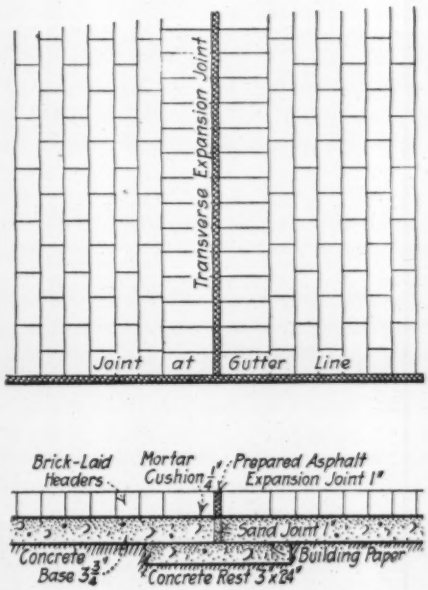

FIG. 2. SPECIAL JOINT FOR BRICK PAVING AT MARSHALL, ILL.

Another special feature of the joint is the laying of the brick as headers, with the prepared joint between the heads, as shown in Figs. 1 and 2. Laying the brick as headers at the end of all street intersections, which takes the place of marginal curbing, is another special feature. This is shown at *B* in Fig. 1. The theory for this arrangement is that the weakest point in the pavement, and the point most exposed to traffic, is at the joints and at the end of the intersections. By laying the brick as headers a longer bearing is given for resisting the impact from vehicles and from horses' hoofs.

Difficult construction was encountered in building the extension of the 60-ft. roadway from the property line to the curb line of the intersecting street, which was put in on the monolithic system. This had to be done by hand, using the method above described for building street intersections, and excellent results were obtained.

The most difficult construction encountered was in extending the 60-ft. pavement to connect with a diagonal street and also a street at right angles, the center line of the diagonal street and the right-angled street being 11 ft. apart.

From the contractor's point of view there is one feature that is of particular interest in this type of monolithic construction; namely, the work can be done under the supervision of one general foreman. This is for the reason that the work is all kept together, and when the day's work is done the contractor has a completed pavement.

The advantage to the municipality is that the street can be opened to traffic within two weeks after the street is completed, instead of waiting seven days for the concrete base to set and then waiting ten days after the brick are laid and slushed before opening the street. The pavement is also noiseless in comparison with the sand-cushion type, the difference being very noticeable on West Main St. where the old paving joins the new.

The contract is being executed by the H. Pfizenmayer Construction Co., of Terre Haute, Ind., under the direction of Paul Meredith, superintendent and member of the firm. L. E. Grammer is principal assistant for the writer.

Method of Obtaining Cost Data

An accurate account of the construction cost is being kept. The cost of the labor is divided among the mixing and placing of the concrete base and mortar cushion, bricklaying, and slushing or grouting. The overhead charges, being constant, are divided equally among these three branches of work; these charges cover the foreman, timekeeper and water boy.

The crew for mixing, placing and shaping the concrete and mortar was as follows: One engineman, one subforeman, four wheelers, four shovelers, nine men on the mixer and spreading, and three men mixing mortar. For bricklaying: Two brick setters, twelve carriers, two rollers, one sweeper and one batter. The crew used for slushing or grouting was made up from the bricklaying and mixing crews. This is a general statement of the number of men used in the crews, which of course varied from day to day.

Accurate account was kept of the cement used for slushing and for the concrete base. The cost of each day's work was kept separate and the result tabulated. By this method the cost per square yard for each division of labor was obtained and the material required per square yard was determined.

Restoring Flood-Wrecked Well and Pumping System

By A. C. Francis*

Among the extensive repairs to the San Diego waterworks necessitated by the flood damage of January, 1916, is the reconstruction of the Mission Valley pumping station, a 5,000,000-gal. plant put in use in December, 1914, as an auxiliary to the mountain storage-reservoir system. This reconstruction is just being completed under the direction of F. M. Lockwood, Manager of Operation of the City of San Diego.

From Jan. 25 to 29, 1916, it was a night-and-day battle with the flood waters of the San Diego River to save the main pumping plant from destruction. As it was, a portion of the concrete sump was wrecked, the pipe lines from the wells to the main pumping station were washed out, the field pumps and motors were carried downstream, and the chief pump engineer's cottage, together with his garage and automobile, were swept away by the flood.

Although nature wrecked the field plant, still nature, assisted by the ingenuity of the men in charge of the flood work, undoubtedly saved the main plant. The main pumphouse and sumps are located just below an immense gulch in which had been placed a 30-in. concrete drain pipe to carry the storm water from the residence district on the mesa high above the plant. This drain discharged near the pumphouse, and the water from it was cutting in very close to the concrete sumps. At the same time the river was washing up nearer and nearer to the main plant, and for a time it looked as though nothing would save it. As something of an experiment, a force of men was sent up the gulch to the mouth of the drain with orders to shovel rock and dirt into the pipe. The drain carried the material down to the plant and deposited it just below the discharge end of the drain, where the water was cutting in near the sump. As the deposit filled up the cut to the end of the drain, the pipe was broken off length by length to allow the fill to be made farther back. In this way a solid earth and rock fill was made in the cut, and the flood waters were turned away from the plant.

The work necessitated by the flood was the recovery of as much of the old field plant as was possible, the drilling of nine new wells, alterations to the main plant, the installation of a complete new system of water delivery by air lift from the wells to the main plant, and protec-

*City Hall, San Diego, Calif.

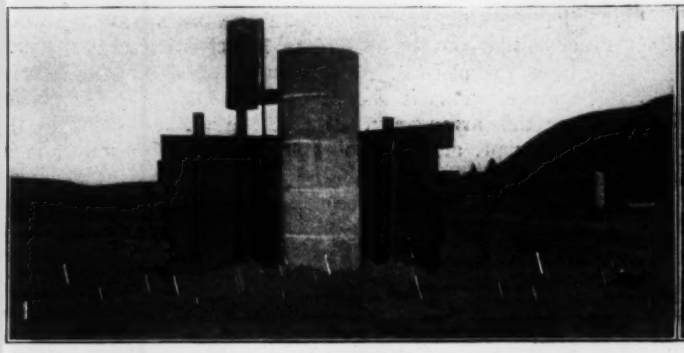

FIG. 1. GENERAL VIEW OF TWO WELLS, SHOWING INTERIOR OF WEDGE PROTECTION

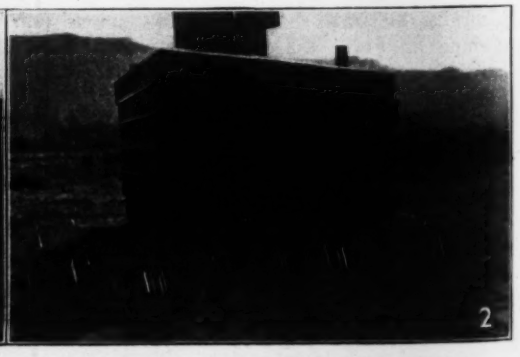

FIG. 2. EXTERIOR VIEW OF PROTECTING WEDGE, SUPPORTED BY OLD STEEL RAILS

tion of the field plant from future destruction by flood waters.

The cost of the entire job was close to $26,000. The work of recovery of the old field plant and general reconstruction will run approximately $5,700; the air-lift system of transmission from wells to plant cost $11,270; the new wells completed cost $8,069; a survey of the property, $356; and the protection of the field plant, about $700.

The pumping plant as originally constructed consisted of 12 drilled wells, in depth from 40 to 90 ft., from each of which the water was lifted by means of a small two-stage centrifugal type of pump driven by a 10-hp. belted electric motor. The water was driven from the pumps to a concrete standpipe and thence to concrete reservoirs through steel force mains. From the reservoir the water was lifted to the University Heights reservoir by two direct-connected four-stage centrifugal pumps driven by two 250-hp. motors.

The field plant suffered flood loss severely, only three of the wells, five of the pumps and six motors being recovered after the waters had receded.

Owing to the failure of the Lower Otay dam and of both the Otay-San Diego and the Bonita pipe lines in the Sweetwater Valley, it was of vital importance to place the Mission Valley plant in operation.

Accordingly a temporary sump, 30x80 ft. in plan and about 12 ft. deep, was dug and boarded up about 35 ft. east of the concrete settling basins and sumps. Two electrically driven pumps, one a 7-in. and the other a 10-in., were placed on the bank and pumped from the river sand into the concrete basins from which the main plant lifted the water to the University Heights reservoir.

This temporary supply was first delivered on Feb. 18, just 22 days after the big flood had wiped out such a large portion of San Diego's water system. The plant furnished an average of a little over 4,000,000 gal. daily until July 9, when the Otay-San Diego pipe-line repairs were completed and the water turned in from the Upper Otay reservoir.

During this period an effort was made to recover the 12 wells in the field of the old plant, but only three of the wells could be located. These three wells were cleaned out and contracts let for the drilling of nine new wells. The wells just drilled are each 100 ft. deep. The three old wells that were recovered run from 58 to 80 ft. in depth. The water stratum is about 15 ft. thick and is found between the 40- and 60-ft. levels. The wells are 12 in. in diameter to a depth of 60 ft., or through the water-bearing stratum, and 8 in. below that level, the continued depth giving submergence for the air-lift system.

For some time prior to the flood that made reconstruction necessary Mr. Whitmore, the master mechanic of the City Operating Department, had been considering the air-lift system as a means of delivering the water from the wells to the main pumping plant. His investigations gave him reason to believe that this method would be less expensive both in operation and maintenance than the field pumps and motors.

As the field plant had been completely destroyed, it was decided to put in the air-lift system. The lift installed is the plant of the F. J. Kimball Co., Los Angeles, and consists of two 17x10x14-in. Ingersoll-Rand air compressors, of a guaranteed capacity of 900 cu.ft. of free air per minute for each compressor against a 30-lb. pressure, and with a speed of 185 r.p.m.; two 75-hp. 440-kv.-a. 60-cycle 900-r.p.m. motors; and 12 patent air-lift apparatus with a guaranteed capacity for each apparatus of 500 gal. per min. with a submergence of 60% and a guaranteed efficiency of 30% for power delivered to the belt wheel of the compressor.

The air-lift system, when tested out, proved to be satisfactory from the start. There is no field trouble to care for, and the saving effected in salaries of pump operators alone is $370 per month, to say nothing of the saving in the maintenance of the field pumps, which was running close to $130 a month.

Furthermore, under the old system of field pumps and motors it was impossible during stormy weather to operate the field plant, as most of it was under water. With the air-lift system the plant may be operated just as long as the wells and transmission lines remain intact, as the whole plant is operated from the main pumphouse by one man.

Alterations were also made in the arrangement of the main plant. Before the flood the main pumps had to operate through a suction line, in which there were nine bends. Mr. Whitmore abandoned this suction line and drove a tunnel from the sump to a point under the pumphouse directly below and between the two pumps. Here he made a concrete-lined pit 6x8 ft. in plan and 16 ft. deep, into which the tunnel from the sump discharges by gravity and from which suction pipes with only one bend lead to each of the main pumps. This change increased the pump capacity just 100,000 gal. per day. The plant has a total capacity of 4,000,000 gal. daily when delivering the water over the aërating table at the University Heights reservoir, and 5,000,000 gal. when discharging direct into the main.

The 12 wells are connected to the sumps by 10-in. branches, and 412 ft. of 20-in. and 1,600 ft. of 24-in. mains, all of steel.

In order to protect the wells from being torn out during stormy weather by floating débris the department has placed a wedge constructed of heavy timber and railroad iron in front of the wells, with the nose pointed upstream. Three 30-lb. rails were driven to a depth of about 24 ft. in the sands, and the wedge was constructed around these rails out of 3x12-in. planks 12 ft. long. The wedge extends 6 ft. below the surface of the sand and 6 ft. above, the upward extension being for the purpose of protecting the wells not only from floating débris, but also from shifting sands under the surface of the water.

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Proposed Highway Commission of Texas—The passage of the Federal-aid road bill has been influential in bringing the largest state in the Union to consider state road construction. The committee recently appointed by Governor Ferguson of Texas to draft a bill creating a state highway commission has completed its work, and the bill will be presented at the next meeting of the legislature in January. If carried, the law will provide for three highway commissioners, only one of whom will reside at the capital and devote his whole time to the work. His salary will be $4,000 per annum. The other two members will be paid on a per diem basis not to exceed $1,500 per annum. It is proposed to raise a state highway fund of about $2,000,000 a year by a state tax on automobiles, from a minimum of $7.50 to a maximum of $15 per vehicle, according to horsepower. One-third of this fund would be returned to the counties for the maintenance of state highways under the supervision of the State Highway Department. The other two-thirds would be used for construction of state highways.

Underpinning with Hollow Piles Driven with Point

By G. L. Knight*

SYNOPSIS—Two-story building underpinned for unit load of 600 lb. per sq.ft. and increased to four stories. Special piledriver drove hollow steel piles 25 ft. with lower ends closed by a special projectile-shaped point.

In the fall of 1915 the necessity for further extension to the Gold St. power house of the Edison Electric Illuminating Co., of Brooklyn, N. Y., involved the construction of additional electrical galleries for switch and bus compartments and additional quarters for plant-efficiency and laboratory work and for operating and construction offices.

On the site required for the addition the company had erected in 1910 and 1911 a two-story building 40x97 ft., to act as quarters for storeroom, machine shop and locker and toilet rooms for the employees of the plant. This building was erected between the end of the operating room and the south boiler house, as shown in Fig. 1. Although the soil on which the foundations for this building were placed is of very poor quality—consisting of deep fill throughout the entire area, where a dock once stood—the loads carried were light and necessitated only spread concrete footings.

The new demands, however, required the construction of a four-story building over half the area occupied by the first building and with very heavy loads—600 lb. per sq.ft.—due to the masonry switch and bus compartments on the upper two floors. These loads, together with the heavy structural work and concrete and the necessity of maintaining a driveway from the street through part of the grade floor, required a very careful location and as few columns as possible and made the loads unusually heavy on each. Fig. 3 shows the plan of the floor, the location of columns and the loads on each.

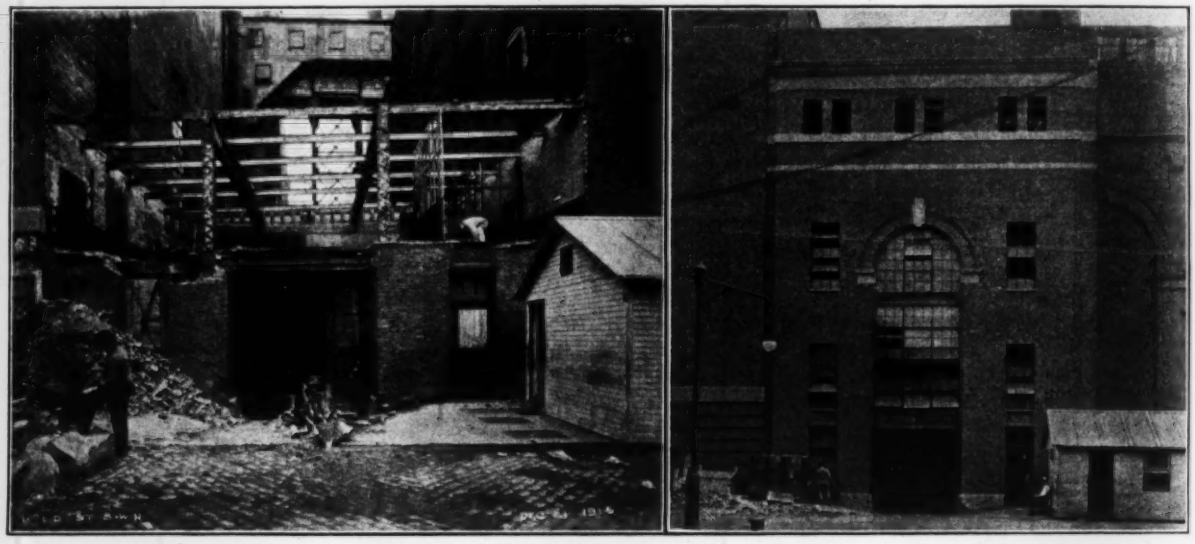
A study of conditions and test borings showed that piles would be required. The choice lay between wood, driven or jetted, hollow steel piles driven open-ended and dredged out, or the same driven closed.

Pits Dug and Hollow Piles Driven with Point

Previous experience in the immediate vicinity showed that serious difficulties were to be expected in driving, as the fill was full of stones and boulders where was formerly the old beach. The borings led to the conclusion that a stratum of boulders was likely to be encountered, large ones at the undisturbed beach line and smaller stones in the cribwork and fill. Such conditions eliminated from consideration wooden piles. The sectional tubular-steel closed pile driven with a point, being much the cheaper, was chosen. In order to prevent these piles from being stopped by boulders it was determined to excavate each pit in open sheathing to as deep a point as water conditions would permit, removing the boulders and stones as the excavation progressed. This method proved entirely feasible and was so satisfactory in the case of the first pier that it was carried on throughout.

The new foundation work was made especially difficult by the fact that the existing building had to be shored and maintained throughout the progress of the work, the front wall and roof being the only parts removed.

The contractor was required to build a temporary wooden roof and make it water-tight before the roof concrete and structural steel could be removed to provide for the construction of the additional stories, and to



FIGS. 1 AND 2. BEFORE AND AFTER RECONSTRUCTING THE SHOP AND WASH HOUSE, BROOKLYN EDISON CO.

*Designing Engineer, Edison Electric Illuminating Co., 360 Pearl St., Brooklyn, N. Y.

build temporary partitions back of the front wall to afford like protection.

As the headroom for piledriving was extremely limited, the contractor constructed a special set of ways for his driver, in the design of which provision was made for changing the position of the ways both as to angle and height, as described in *Engineering News*, Sept. 7.

Two-inch tongue-and-grooved sheathing braced with 4x6-in. timbers 4 ft. apart vertically were used for each pit, and the excavation was carried down an average of 13 ft. below basement-floor level. The steel-pile sections were 12 in. in diameter, with a 3/8-in. shell. The first section was 20 ft. long and was fitted with a cast-steel point especially designed for and used the first time on this job. The piles were driven to an average depth of 35 to 50 ft., which means a penetration of 22 to 27 ft. below the bottom of the excavated pit, in some cases going as far as 30 ft.

In driving, sections were used according to the expected lengths at which the pile would bring up, the intention being to cut the piles off at the proper height for concreting under the foundation pier. Where the

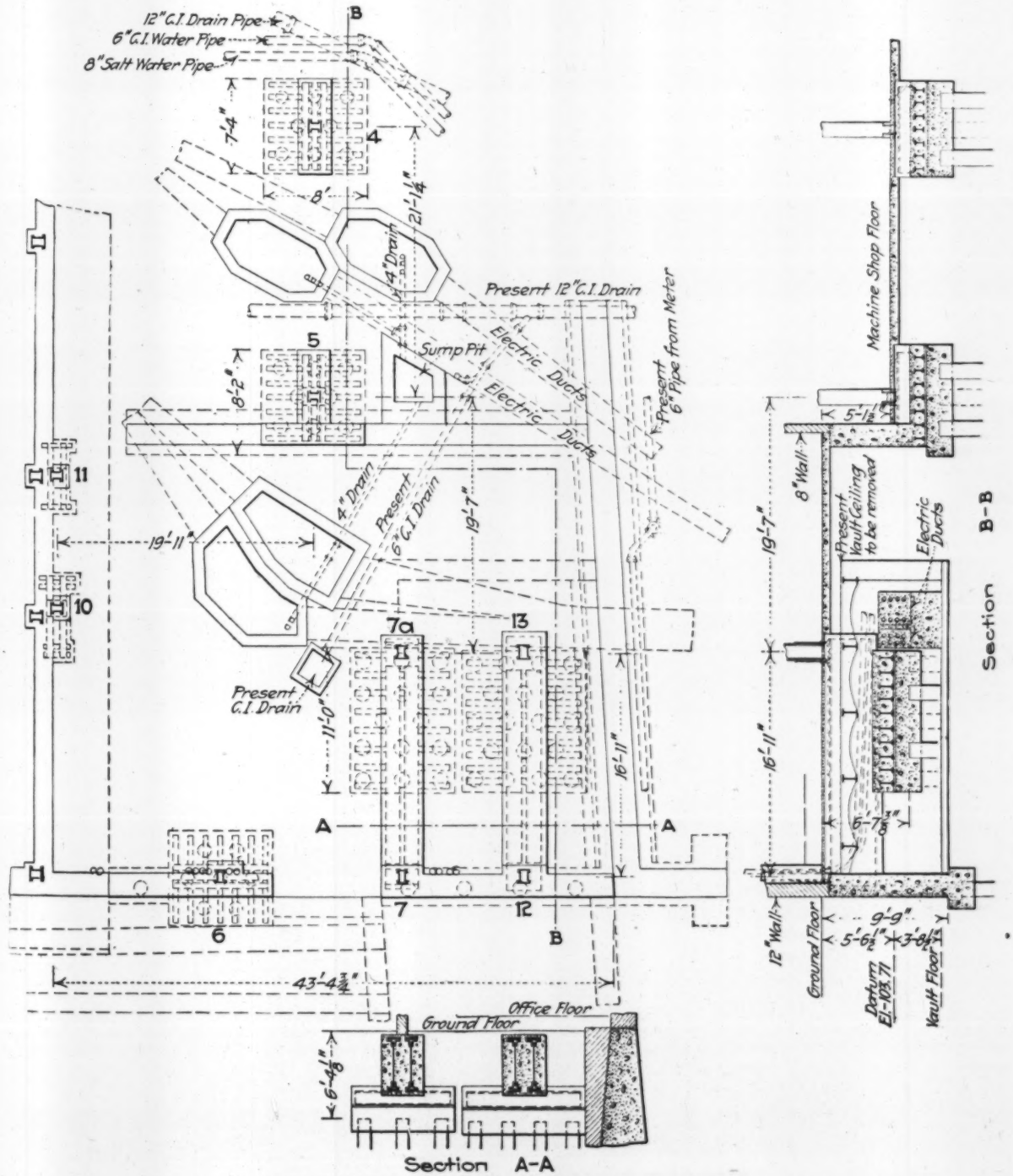


FIG. 3. FOUNDATION PLAN OF REMODELED BUILDING

length of the top section was too great at refusal, the piles were cut off with a hacksaw. Where a joint came in the excavating pit, concrete was placed around the joint to act as additional reinforcement.

Each Pile Inspected Inside with Electric Lamp

As the driving finished on each pile, an incandescent light was lowered to the bottom of the pile to ascertain that the pile was in perfect condition, before concreting. In a few cases the joint between the point and the first section had opened slightly and water came in, but in most of the piles the light lowered to the bottom of the point showed a perfectly dry, clean shell. The sleeves between sections were of the cast-steel inside type.

When all the piles had been driven in one pit and cut off at the proper height, they were filled with concrete, and the entire pit was backfilled to mean tide level, below which they would be permanently wet and therefore little subject to corrosion. The fill was left 6 in. below the top of the pile, and the concrete pier foundation for the columns was installed from this grade to grillages, as shown in Fig. 3.

In the large double piers at the front of the foundation, marked 12 and 13, a mattress of boulders was encountered that occupied practically the entire area, one boulder being about 10 cu.yd. in volume and another nearly as large. It might be asserted that with such a condition it would have been better engineering to put concrete in the hole from that point up, but after the boulders were removed the piles went down easily to a depth of 25 ft. below the boulders, and the condition of the soil below the boulders was of such consistency that no confidence could be placed in its bearing capacity. Following are the details of the work in each pier:

No. 4 Pier—The concrete pier under the previous column was found to extend about 5½ ft. below the floor line. Stone fill (one-man stone) and mud was found to extend from bottom of concrete to a point 8 ft. below the floor line, where the bottom of an old crib was uncovered. The bay uncovered was one that had been decked over to anchor in place of the crib of round logs. This timbering was cut out, and from the bottom of it (9 ft. below the floor line) to a point 12 ft. below the floor line mud and an occasional stone were found.

When the excavation was completed to this depth, the ground was sounded with a bar and, as no stones were found, driving was started. The first four piles went down comparatively easily. The next one hit an obstruction about 6 ft.

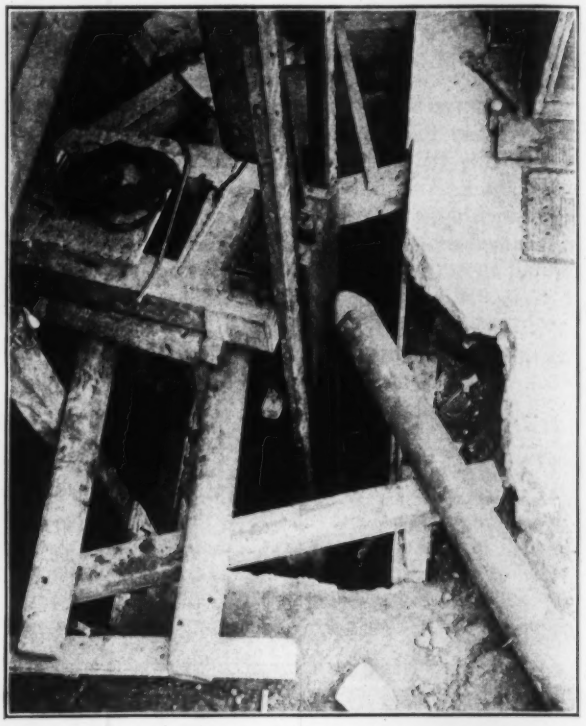
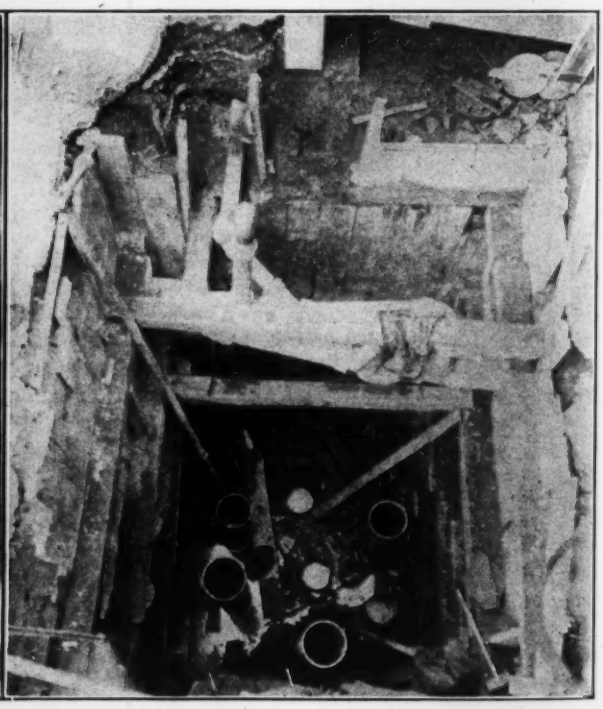


FIG. 6. SHOWING PILEDRIVER LEADS IN AN EXCAVATION, AND A HOLLOW PILE WITH POINT ATTACHED



FIGS. 4 AND 5. TWO VIEWS OF A PIER EXCAVATION

below the surface of the excavation, which caused it to ride off out of position. The pile finally passed the obstruction and was driven practically to the same depth and refusal as the others. The remaining piles drove very hard, evidently due to the fact that the earth had been compressed by the driving of the previous piles. No. 6 pile also rode off a boulder and drove down out of line and very hard. Just before driving was stopped on this pile, the top of the pile under the ring crumpled up, corrugating the pile down from the top about 18 in. The same thing happened to No. 8 pile. There was no sign of a fracture of the steel in either case. Photographs were taken of these corrugated tops.

In cutting the tops of the first pile sections it was decided to use an acetylene burner so as to get a true bearing for the top section, but this was found to be not as satisfactory as the hacksaw cut with guides. When the top sections were put on it was agreed with the contractor that he should place a layer of concrete that would extend about 9 in. above and 9 in. below the joint of the first and top sections, to reinforce the joint where the metal was not continuous.

No. 5 Pier—Practically the same condition as regards excavation was found here as in the case of pier 4, except that no cribbing was uncovered and it was found necessary to go down 14 ft. instead of 12 ft. below the floor, owing to the small boulders that were found as soon as the 5½ ft. of concrete had been cut through.

Piers 7, 7-A, 12 and 13—In these piers the whole area was excavated to a depth of about 19 ft. below the driveway, or approximately the same depth below datum as pier 5, the general character of the excavated material being the same as in preceding piers.

Driving was started in the excavations for Nos. 7 and 7-A, and everything went well except that sometimes a pile would strike some obstruction and ride out of line. When driving was started on Nos. 12 and 13, however, it was soon found that there was a large boulder about in the center. This proved to be about 7x11x4 ft., and after it was removed another about the same size was found directly under it. During the removal of these boulders most of the other piles of piers 12 and 13 were driven, and consequently the five piles located in this area drove very hard, and in one or two cases the tops of the piles were crushed. Pier 6—Contrary to the conditions found in the other holes, these piles, instead of driving to a proper refusal at 20 ft., continued on down and did not fetch up until they had reached a penetration of about 40 ft. All the piles went down very nicely except No. 1. The first section driven for this pile was about 20 ft. long. When this was driven down to the bottom of the ways, it was still going easily (about 12 in. in 50 blows). Another 20-ft. section was put on with a sleeve, and the driving was resumed. The penetration continued to be very even, with a difference of not over 3 or 4 in. for every 50 blows. When the top of this second section reached the bottom of the ways, the driving was stopped and the cap taken off the pile.

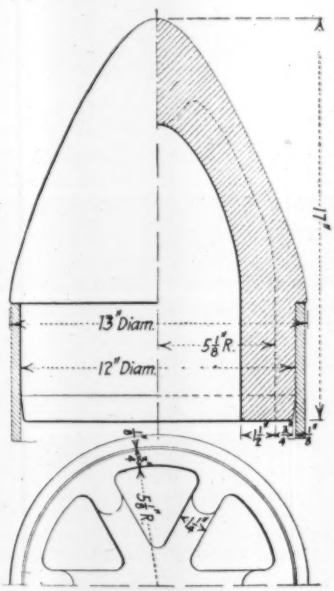


FIG. 7. CAST-STEEL POINT USED FOR PUTTING DOWN HOLLOW PILES EMPTY

The pile was found to be full of very warm water. As it was believed that something had happened at the joint of the two sections, because in other cases the joints had been almost water-tight, a pump was placed in the pile and the water pumped out to a depth of 14 ft. below the top of the pile. At this point the sleeve was found embedded in mud and sand, showing that the sleeve had collapsed and the two sections had separated. The sleeve had been driven up in the top section for a distance of 6 ft.

It was also found, when the collar was removed from the top of the pile, that the pilehead had collapsed for the distance just covered by the collar.

The contract for the entire foundation work was executed by John H. Duncan, Brooklyn, on the unit-price basis, under the supervision of G. L. Knight, Designing Engineer, and H. B. Morrison, Chief Inspector of Building Construction of the Edison Electric Illuminating Co., of Brooklyn. Bernt Berger was consulting engineer both on design and on fieldwork.

Will River Traffic Follow River Improvement?

That river improvement for navigation will surely develop and encourage river traffic is a common argument in favor of such improvements. It remains to be seen, however, whether commercial interests will avail themselves of the opportunities afforded, and will develop traffic to an extent commensurate with the vast sums expended on the improvements. This situation was brought out pointedly at the recent meeting of the Upper Mississippi River Improvement Association in an address delivered by Thomas Wilkinson (Burlington, Iowa), the President of the association. The following is an excerpt from his address:

Including the appropriation made this year, there has been appropriated nearly half of the $20,000,000 originally estimated as the cost of the permanent improvement of the river to obtain a permanent channel at lowest stage of water. The work has progressed so far that the river is now safely navigable for almost any amount of traffic, except at a few crossings that could easily be dredged at extreme low-water. Where are the facilities, the towboats and barges and the cargoes they should be carrying on its waters, to mark a revival of river freight transportation, and make it a living part of the great transportation system of the country?

When the work is completed and the river permanently improved at the expense of the vast sum it will have cost, what use will be made of it? Any popular demand for waterway improvement is absolutely wrong unless it is intended to become and does become construction and makes the stream an actual carrier of commerce. While Congress has been liberal in responding to demands for these improvements, there is grave danger that appropriations will be curtailed, or even discontinued unless there is speedily manifested a disposition to use the improved waterway in some measure proportionate to the cost of the improvement.

Attention has been repeatedly called to the indispensable factors requisite, and the things needed to be provided by the communities themselves, for a successful revival of river traffic. As one of the prime essentials, they have been urged to construct permanent wharves and install adequate terminal facilities (equipped with mechanical devices) adapted to the coördination and easy service of transportation by road, railway and waterway. Some progress is being made in this direction, but not enough. Although a number of cities have terminals under construction, none are yet completed.

The establishment of through lines of freight carriers for continuous service between upper Mississippi River points and New Orleans, is a paramount necessity that must appeal to every shipper.

To handle economically at the least cost of service, the amount of freight that ought to be attracted to the river, there will be needed great fleets of modern towboats and barges, designed to carry large tonnage of any class of freight offered, throughout the entire season of navigation. To transport one million tons of freight would require 1,000 barge loads of 1,000 tons each. Many millions of tons of the products of the valley ought to be carried on the river every year.

The State Cannot Compel Railway Construction to be undertaken, according to a decision of the Supreme Court of California. In 1891 a 12-mi. line, owned by the Santa Fe R.R., between Temecula and Oceanside, Calif., was destroyed by a flood and has never been rebuilt. Last year the State Railway Commission, in response to a petition of citizens, issued an order to the railway to rebuild the line. The Santa Fe opposed the order, holding that the business resulting would not warrant the outlay of $650,000 required to rebuild the line. The Supreme Court in its decision holds that to require a public utility to devote its profits to service that it has never undertaken to render is to take its property in violation of the Federal constitution.

General Goethals on the Panama Canal Slide Critics

SYNOPSIS—In his annual report to the Secretary of War General Goethals, Governor of the Canal Zone, makes his final statement on the slides in the Gaillard Cut. The essential features of his discussion are given here.

In September, 1915, when the International Congress met at San Francisco to celebrate the completion of the Panama Canal, with General Goethals as the guest of honor, news came that the slides, which had been in a threatening condition for months, had moved down so as to block the channel entirely and suspend navigation through it two days before the Congress opened. General Goethals immediately returned to Panama to take personal charge of the work of removing the slides and restoring the canal to operating condition.

It will be recalled that the news of the serious nature of these slides started a wave of widespread public skepticism regarding the canal. Doubts were expressed regarding its permanence and success. The public opinion on the matter was pictured perhaps by the joke that became current about that time—that while the canal had been in Panama, now Panama was in the canal.

Even among well-informed engineers there was an exaggerated idea as to the effect of the slides, and suggestions were heard in various quarters that perhaps the engineers on the Isthmus might have adopted some better plan of dealing with the slides.

Just a year ago, in *Engineering News* of Nov. 25, 1915, was printed the special report of General Goethals to the Secretary of War, detailing the condition of the slides at that time and the methods being adopted for their removal. That report gave facts enough to satisfy intelligent critics; but it did not stop criticism.

The long period of seven months while the canal was blocked with slides offered a magnificent opportunity to those who desired to spread pessimistic views of the canal enterprise and to the amateur engineers who were ready to volunteer scientific theories as to the cause of the slides and propose new inventions for their cure.

Is the Cut in a Bog?

In the annual report of General Goethals as Governor of the Canal Zone, made public on Nov. 20, he replies to these critics, amateur and otherwise, in most vigorous fashion. He introduces the subject as follows:

> Although the question of the slides has been dealt with in previous annual reports and official documents, there continues to exist much ignorance on the subject. Also a great deal has been written by those whose little knowledge makes them dangerous, and to whose statements credence is given because of the position or prominence of the writers. I have concluded, therefore, to report again on the situation, even at the expense of repetition, notwithstanding the general belief that anything published in annual reports is buried in oblivion.
>
> A report emanating recently from English sources states that the bottom of the canal through Gaillard Cut is found to be a bog, which is being constantly pushed up and through which the dredges have difficulty in maintaining a channel. Further, that it is acknowledged on the part of those in charge that the canal is a failure and that American engineers are seeking information in England relative to the Nicaragua route.

General Goethals answers this story with the terse remark that such reports are false and that the bog theory is a myth. The latter part of the story may possibly have originated because of the pending treaty between the United States and Nicaragua, by which the former secures from the latter all rights for building a canal on Nicaragua territory. It would be absurd for the United States to seek information concerning the Nicaragua canal route in England, however, in view of the complete information as to that route obtained by the United States Government 20 years ago, before the Panama route was adopted.

If anyone believes that the bottom of the Gaillard Cut is in a bog, he would do well to reflect that every foot of the existing channel through it was excavated through rock so hard that it all had to be drilled and blasted.

For some unaccountable reason there seems to be a general belief that the whole Gaillard Cut, 8¾ mi. long, is affected by slides. The fact is that the only slides of importance are those at Culebra and at Cucaracha, and these have a combined length of only 4,800 ft.

Another frequent misconception is that these slides represent the slipping down of portions of a bank to reach a slope at which the material will stand. The fact is that the slides which have given serious trouble are caused by a deep subterranean movement. The underlying strata have been deformed or crushed under the weight of the overlying material, which has settled down vertically.

Scientists Volunteer Expert Advice

For a number of years the staff on the Isthmus included a resident geologist, Donald F. MacDonald. Notwithstanding this, there appears to have been considerable sentiment among geologists and mining engineers in the United States that if their wisdom was directed toward the slide problem at Panama they might be able to do better than was being done by the engineers in charge. We quote further from General Goethal's report:

> In October, 1915, the President of the United States was advised by a member of the National Academy of Sciences (which was organized by an act of Congress to give expert advice to the President and Congress on scientific matters) who stated that one of its members had made an extensive study of earth slides in tropical countries, and was convinced that there were relatively simple ways by which they could be stopped, and suggested that a committee of mining engineers and geologists of the Academy be appointed to consider his propositions.
>
> In consequence of this, the President of the United States requested that a committee be appointed by the National Academy of Sciences to "consider and report upon the possibility of controlling the slides, which are seriously interfering with the use of the Panama Canal." From the correspondence it appears that at a meeting held in New York, ". . . the hope was repeatedly expressed that an effective solution may speedily be found."
>
> The coming of the committee was welcomed on the Isthmus, for so much misinformation had been sent broadcast, doing more injury to the canal than the closing of it by the slides, confidence had been upset; and it was hoped not only that a remedy would be forthcoming, but that the report of the committee would be able to restore confidence in the project, especially as those connected with the work knew that the methods adopted would overcome the difficulties for good and all, given the time and money, and that the waterway would be all that had been expected.
>
> Probably the greatest injury done the canal was through Prof. Benjamin Le Roy Miller, Ph. D., who occupies the chair of geology at Lehigh University. On returning to New York

from Costa Rica he stayed here a couple of days awaiting a steamer. He was given every facility to examine the slides at Culebra, which were then at their worst, and he is reported to have said for publication on his arrival in the United States that he had made a "thorough examination of the slides," and the conditions found were as follows—the statement appearing in quotation marks in the press item:

At the Culebra Cut . . . cracks have formed over 1,300 ft. back from the canal, and all of the ground intervening is moving toward the Cut. There is no doubt that much rock, now apparently stable, also will move, as its support is withdrawn by the removal of loose earth and rock. Before the canal can be said to be completed and permanently opened to traffic, the amount of material that must be taken out will not fall far short of the amount already taken from the Culebra Cut.

Transportation companies planning to use the canal should realize that they must not expect uninterrupted service for several years. During the dry season the canal may be opened, but it is certain to be closed during the rainy season when the earth is soaked with water and its movement toward the canal facilitated.

In view of the extent of the material that has now started toward the Cut, it seems that steam shovels should again be employed. Practically all of Gold Hill and much of Zion Hill must be removed, and to wait until the earth breaks loose and enters the Cut where the dredges can attack it seems unwise, and unquestionably longer delays the completion of the project. If dredges alone are employed, as at present, the canal may be kept clear during the months when rainfall is lightened, but for many years to come the rainy season is almost certain to cause such slides as to close the canal for weeks or even months.

The "thorough examination" occupied fully three or four hours of his time. The position that he occupied in one of the leading universities of the United States gave credence to his statements, which were copied broadcast and commented upon editorially to the detriment of the canal. His dire predictions were naturally unsettling to shipping interests, which were guided by them to some extent in routing their commerce elsewhere.

It was anticipated that the committee from the National Academy of Sciences would make a more thorough examination than Professor Miller had done, and it was hoped that, as a result, the statements of Prof. Benjamin Le Roy Miller, Ph. D., would be found to be what we considered them—erroneous, unwarranted and unfair, and help restore the confidence that he had helped to destroy.

The preliminary report by the committee of the National Academy of Sciences was submitted to the President in January, 1916. ["Engineering News," March 16 and 30, 1916.] At that time they expected that their final report would be completed in April, but up to date it has not been received.

The statement made by Professor Miller, that practically all Gold Hill and much of Zion Hill must be removed, was not concurred in; and in this connection it should be remembered that a committee of this character expresses its opinions guardedly, for whatever happens they must be found on the right side. They advocated, as a matter of scientific interest, the making of an accurate triangulation of the hills in question—Gold, Contractors, Culebra and Zion—which has been done. By checks made at frequent intervals the slightest movement on the part of any of the four hills would be disclosed at once. No movement of any kind has taken place.

The committee expressed the belief that every available and practicable device for controlling the water, both on the surface and underground, should be employed, and to this end advocated covering the slopes with vegetation to prevent surface wash, closing peripheral cracks, draining undisturbed and threatened areas and draining by tunnels.

Remedies Proposed for Stopping the Slides

1. Covering the Slopes with Vegetation—Probably the most frequent remedy suggested for the Panama slides (especially by those who have never been to the Isthmus and have no conception of what the slides are like) is planting vegetation to cover the banks. E. Moody Boynton, famous 25 years ago as the inventor of the bicycle railway, has exploited in the public press (and patented!) a scheme for planting willows on earth slopes to prevent slides, which he advocated as just the thing for the canal. General Goethals' comment on the general scheme of planting vegetation to stop the slides is as follows:

For several years the expedient of covering the slopes with vegetation has been carried on, starting under the direction of Dr. Pittier, of the Smithsonian Institution. Where the surface of the ground is in motion, as in the case of active slides, the roots are disturbed, and the steady growth of vegetation is impracticable. Trees and vegetation of all kinds growing on the surface of the ground which broke in October, 1914, were carried down the slide and exercised no deterring effect whatsoever. On sliding ground there is not sufficient time to plant anything, and no good would be accomplished. Where the banks consist of the red clay of the country, it is only after considerable difficulty that grass of any kind can be grown on them. Vegetation stops surface erosion; on this account the work above noted was undertaken and is being carried on.

2. Filling Up Earth Cracks—General Goethals remarks that this remedy may be adopted with success where sufficient earth covering is available for the use of a hydraulic grader, and this has been done at places along the canal. The smoothing off of the slope with a hydraulic grader also permits ready runoff of the water. As long as the ground is in motion, however, new cracks and irregularities are constantly developing, so that until the material comes to rest relief is temporary only. On Culebra Hill, where there is little earth covering and the cracks are wide and extend a great depth in rock, it is not practicable to close them permanently without expense unwarranted by the results.

3. Subsurface Tile Drains—In accordance with the recommendations of the committee while on the Isthmus, subsurface tile drains have been placed within an area on Culebra Hill as an experiment. As for the general effect of such drainage on the earth movements, General Goethals says:

It is admitted that if the water could be entirely excluded the earth movements would cease, but unfortunately this is impossible. With the heavy tropical downpours the best that can be done by drainage is to carry away what falls as rapidly as possible, but groundwater cannot be eliminated. So far as concerns groundwater . . . the slides in question affect the banks for a considerable distance down, probably below the bottom of the canal, and if groundwater be primarily the cause, then it cannot be removed from the strata at which the trouble starts.

So long as the slides are active and the configurations of their surfaces change as rapidly as they now do, it is impracticable to open and maintain the permanent drains recommended in the moving areas. When equilibrium is restored, and as a means of promoting permanent stability, the drains of a permanent character should be constructed and maintained.

4. Drainage by Tunnels—As noted above, this was one of the expedients for stopping the slides suggested by the Academy of Sciences Committee. The chairman, Dr. Van Hise, President of the University of Wisconsin, proposed experiments to try out this plan, and the services of Prof. Warren J. Mead, of the University of Wisconsin, were secured. Professor Mead, in coöperation with Mr. MacDonald, the Canal geologist, made tests to determine the percentage of water contained in the rock which might be drained off by a tunnel.

Tests were made on 21 samples of rock taken from below the canal water level and showed that most of the water contained in the rock was held there by capillary attraction and the maximum amount that could be removed by natural drainage would not exceed 3.6% of the total volume of the rock. Mr. MacDonald's official report says:

These facts show that while the sliding rocks have a high percentage of pore space, the pores are mostly of capillary size and are filled with water which obeys the laws of capillarity and which cannot, therefore, be drained off. These experiments definitely established that all cures by drainage which had been offered to and urged on the canal authorities were absolutely futile, and the money which might have been wasted in worthless tunnels, wells and acres of asphalt covering was saved for the only remedy that could bring premanent cure under the circumstances—dredging.

Other Plans Tried by the Canal Engineers

The engineers on the Isthmus have not been backward in undertaking practical trials of anything that promised even a remote possibility of checking the slides. General Goethals describes these experiments as follows:

During the excavation of the Cut there occurred 22 slides and breaks of various extent. It was believed that piles driven through the loose material into firm ground below and tied at the tops might check the movement, and this was tried at four of the slides, but without success. In some instances the piles were carried bodily down the slope; in others the underlying material, moving faster than the upper portion, inclined the piles away from the Cut, and in cases where the top surface moved faster than at the bottom, they inclined in the opposite direction. The remains of these piles can be seen at the present time in some of the areas so treated.

It was thought that in case of clay slides, heavy riprap dumped on the surface would find its way through the loosened material to firm ground and check the movement; but this method was found as useless as the piling. Most of the riprap rock was taken out at the foot of the slope as the excavation proceeded.

Experiments were made by concreting the face of the prism to prevent the disintegrating effect of the air on some of the softer rocks; this was done by use of a cement gun, by plastering the surface with cement mortar and by reinforced concrete, anchored to the side of the prism with pieces of rail. None of these methods was satisfactory or durable.

The remnants of the French drains, which proved inadequate, were dug out at the bottom of the prism.

The conclusion was reached that the only cure was the removal of all loosened material as it came into the Cut; and in case of breaks, to relieve the weight, where possible, from the upper parts of the banks by steam shovels or sluicing operations.

Other Schemes for Holding Sliding Ground

Many ingenious people have offered to show the canal engineers how to stop the slides. Some of their suggestions are reviewed as follows:

The suggestions most frequently made have been along the line of sowing vegetation and of properly draining the area. These have already been considered. To sink a number of pipes and apply steam for drying out the subsoil would be prohibitive on the score of expense, even if it were practicable. It would be impossible to drive and hold such pipes through the material in case of motion.

Pipes sunk for the purpose of pumping out the water are equally impracticable and impossible. From the experiments conducted by Prof. Warren J. Mead and Mr. MacDonald all the water could not be extracted by this method. Piling the entire area at regular intervals and tying the piles to anchors driven in the firm ground cannot be done, nor would it secure the result anticipated by the proposers of this scheme.

The construction of retaining walls would require the excavation of material to secure the foundations, necessitating the removal of all the material in motion, when the need for the retaining wall would no longer exist. There is no form of construction that could be designed that would hold back the superimposed mass while the excavation for the foundations was in progress. The construction of inverts to hold down the bottom of the prism is impracticable and impossible.

Wire netting rolled over the bank and held in place by stakes would not prevent the movement, but would seriously interfere with the dredges in removing the material littered up with sections of wire mesh, which would break loose with every movement of the slide. Consolidating the mass by injecting grout would also be impossible; the pipes could not be driven to firm ground below, and the earth and rock, as it now comes into the Cut, can be much more easily handled than would be the case were this material solidified by cement.

It was suggested that the slopes and the surface of the ground adjacent to the Cut be covered with asphalt, tar or some preparation which would exclude water from the ground. This was also proposed by a member of the committee from the National Academy of Sciences. That the committee did not include it among its recommendations seems conclusive that in its opinion it was not practicable, and no further comment seems necessary.

Unique Theories as to the Cause of the Slide

The ingenious theory has been put forward that there exists a huge subterranean reservoir of water and it is the pressure from this that causes the slides. General Goethals remarks that since the pressure is sufficient to break the ground, the water would escape through the breaks. No such water has appeared.

Another remarkable theory is that the attraction (of gravitation?) between the earth masses on opposite sides of the cut draws them together, and still another holds that the excavation of the cut has sliced in two a huge magnet that previously existed!

An Ex-Senator Lays It to Gas

Hon. Thomas Kearns, ex-senator from Utah, declared in the New York *Sun* of June 18, 1916, that:

The trouble is all caused by subterranean gases formed in the earth which, when permitted to escape through certain channels or breaks in the earth, carry with them eruptive material, sometimes for a long distance, to the place of the least resistance.

General Goethals comments on this delightful theory as follows:

Coming from a man with such large practical experience Senator Kearns's paper undoubtedly carried conviction to the minds of many who read it. Since his examination was more thorough than that made by Prof. Benjamin Le Roy Miller, Ph. D., it is comforting to note from his judgment also that Gold and Contractors Hills are not likely to fall into the Cut.

According to Senator Kearns's theory, gases forming somewhere in the interior of the earth in escaping carry with them eruptive material to the place of least resistance, or in this instance through the bottom of the canal. The breaks, which produced fissures several hundred feet deep, liberated no gas. With a pressure sufficient to accomplish such destruction of the structural formation of the rocks, apparently the gases returned to their storage to attempt later a forced passage through the bottom.

We unconsciously endeavored to assist their efforts by digging away 110 ft. of their container, but even this did not induce the gases to come forth; thus far there has been no evidence of escape anywhere along the line of the canal, nor has there been any upheaving movement anywhere except in the Culebra district, where the slides occur. So long as there is no movement in the banks we are able to reach bottom grade and keep it. Under the circumstances, those on the work still adhere to their belief that subterranean gases have nothing whatever to do with the movements that have occurred.

What Happened at Gold Hill

The reports that the whole of Gold Hill is moving slowly into the canal should be definitely set at rest by the statements above as to the triangulation measurements. The breakage of enormous masses of hard rock from Gold Hill, however, has been the source of much trouble. General Goethals says:

Gold Hill is of basalt, thrown up in a molten state through the sedimentary deposits that already existed and poured over the deposits on either side of the stem, giving to the vertical section the general shape of a mushroom. The portions projecting beyond the stem, being left unsupported, broke when the material moved from under, and the rock thus detached came down with the rest of the material at Cucaracha. This same action occurred on the opposite side of Gold Hill within a few months after the east Culebra slide became active. . . . .

The finished section from Gold Hill north left an enormous mass of hard rock on the east side and at the northwest corner of Gold Hill. When the break occurred in 1914, this mass of rock was moved slowly into the prism, but finally came to rest and seemed to hold the material back of it, limiting the area of interference in the channel. It stood up boldly for nearly 100 ft. and was designated by the working force as "Gibraltar."

Except at the point opposite "Gibraltar," the width of the canal prism through the slides has now been enlarged by the dredges to a width of 500 ft. instead of 300 ft., which is the standard elsewhere through the cut. This widening was made so that even if further movements of the banks on either side did occur, there would be a good chance that the material could be dredged out as it came in, without stopping navigation.

A year ago, General Goethals estimated that the total amount required to be removed from the slides then in

motion would be between 7,000,000 and 13,000,000 cu.yd. His present report gives the total work done by the dredging division in removing slides during the year as 12,695,000 cu.yd. This material was handled at an average cost of 28.2c. per cu.yd.

A great deal has been said concerning the *esprit de corps* that animated the force during canal construction. Little has been heard, however, of the spirit that has animated the men who battled with the slides during the seven months while ships waited to have the canal reopened. General Goethals says:

> The spirit obtaining in the organization during the construction period was the subject of much commendation; but looking back over the period of my connection with canal work, the spirit that animated the dredging force seems to me to surpass that which existed at any prior period. The dredges were operated 24 hr. every day, including Sundays and holidays, for a period of four months, without the least murmur or complaint on the part of anyone in the force, which reflects much credit on the officials of the division as well as on the men comprising it.

The canal was reopened to traffic on Apr. 15, 1916, and ships have been passing ever since. "So far as the Culebra slides are concerned," says General Goethals, "the worst is over; the intervals between movements are becoming greater and the quantities of material less, the only danger being at 'Gibraltar,' but it is hoped that the excavation continued along the lines contemplated will enable the widening of this section to the adopted prism line without interfering in any way with the transit of shipping. As predicted at the time the great Culebra movements occurred, the slides will be overcome finally and for all time, notwithstanding the calamity howlers and in spite of the disastrous predictions of the 'know-it-alls.'"

Organization of the Engineering Department of a Railway

Railway engineering comprises two branches—construction and maintenance, the former including surveys and location. The relations between these branches and the relation of the engineering department to the operation and management of a railway were discussed in a paper read before the Engineers' Club of St. Louis by V. K. Hendricks, Assistant Chief Engineer of the St. Louis & San Francisco R.R. From this paper we abstract the following review of the work of the railway engineer:

On some railways the two branches—construction and maintenance—are combined; on others they are separate, but come under one chief engineer; and on others they are entirely distinct, each having its own engineer.

Railway organization is ordinarily either "divisional" or "departmental." With the former the division superintendent has charge of all matters of all kinds which arise on his division, while with a departmental organization each division has two or more heads (one for each department) who are wholly independent of each other, and each reports to his own superior general officer. It seems logical that the divisional organization would give the best results, as there should naturally be one supreme head on each division. Probably most railroads now have a divisional organization, except that (especially in the West and Middle West) the local engineering department frequently is not an integral part of the division superintendent's force.

On many railways, especially in the East, the maintenance of roadway, track and structures is directly supervised by a division engineer, who reports on all maintenance matters directly to the division superintendent. The Pennsylvania Lines is a noteworthy example. On that system the benefits of a technical education and training are so appreciated that the line of promotion to division superintendent is generally through the division engineer, rather than through the trainmaster or chief dispatcher, it being essential, of course, for the engineer to develop himself along broad lines and show proper executive ability. All opportunity possible is afforded him to do so. On the Pennsylvania Lines, the general manager has two chief engineers of maintenance-of-way (one for each system) who report to him in a consulting capacity on maintenance matters. The chief engineer has practically no connection with maintenance matters, his duties being in connection with new construction work, right-of-way records, leases, etc.

The Baltimore & Ohio R.R. is another instance of this type of organization. It has four district engineers of maintenance-of-way, who report to the engineer of maintenance-of-way and relieve him of much detail by passing on to him only the more important matters that have previously been fully investigated and summarized. On both the Baltimore & Ohio and the Pennsylvania Lines the engineer of bridges reports to the chief engineer, and the signal engineer reports direct to the general manager.

On the Wabash R.R. each division has an engineer of maintenance-of-way (corresponding to a division engineer), who reports direct to the division superintendent. Between the division superintendent and general manager the organization changes to departmental, as the division superintendent reports direct to the superintendent of telegraph, the general superintendent of motive power, the general superintendent of transportation and the chief engineer of maintenance-of-way on all matters pertaining to their respective departments. These officers in turn report to the general manager. The chief engineer has duties similar to those of the chief engineer of the Pennsylvania.

Still another form of organization is that of the St. Louis & San Francisco R.R. The engineering department does not have charge of maintenance, but is consulted to a greater or less extent on maintenance matters. There are four district engineers who report direct to the chief engineer. They work in close touch with the general superintendents and division superintendents, being consulted by them on maintenance matters.

The engineering department, in addition to having charge of valuation, track extensions, right-of-way records, etc., has charge of all drainage matters, standards, erection of facilities under contract, spiraling curves and general engineering matters. As on the Baltimore & Ohio R.R. and the Pennsylvania Lines, the signal engineer reports direct to the general manager instead of to the chief engineer.

For the best results the engineer should be thoroughly familiar with operating matters, which familiarity can be gained best by actual experience in the operating department. The best ultimate results for the railways will be gained by adopting such an organization as that on the Pennsylvania Lines, where the line of promotion to division superintendent is through the division engineer and thence upward. With such an organization the engineering department would best serve the railway, the engineer would receive his best training, and the railway would be further fortified by generally having its operating officials engineers.

Notes from Field and Office

Michigan pony-truss highway bridges have inside knee-bracing at every panel point—Hunting leaks in water mains—Construction features used by concrete building firm—Asphaltic-concrete paving at Fort Wayne—Tangent of compound curve—Contractor's daily reports—Station work on the Alaskan Ry.

Standard Pony-Truss Bridges for Michigan Highways

By C. V. Dewart*

The standard pony-truss designs of the Michigan State Highway Department have inside knee-bracing at every panel point. These knee-braces are connected to the vertical posts directly underneath the top chord and have a batter toward the roadway of about 1 on 6. They are connected to the web (and not to the top flange) of the floorbeam. The hand railing is connected to the battered braces as shown by Fig. 1. Many arguments have been advanced against this method of construction, but we believe we have effectively answered all. There is greater weight in the floorbeams, but only in the floorbeams. To offset this we have less weight in inside knee-bracing than there would be in outside bracing because no horizontal member is required in the brace. The added length of floorbeam provides a greater width of roadway, for although the nominal width may be only 18 ft., measured from outside to outside of curb, there is actually about 19 ft. clear width at 3 ft. above the crown of the roadway and about 20 ft. clear width at 6 ft. above the roadway.

FIG. 1. MICHIGAN STANDARD PONY-TRUSS BRIDGE

It is obvious that any lateral loading and any tendency to sway in the top chord must be conducted to the floorbeams, and the more directly these stresses are transmitted to the floor beams the better. An outside knee-brace is therefore of little or no value unless it is braced through or around the lower chord and connected to both the top and bottom flanges of the floorbeams. Otherwise the floorbeam connections get all the stress and vibration transmitted from the top chord.

The usual specification calls for a sufficiently increased radius of gyration in the top chord, and vertical posts strong enough, to carry the assumed lateral loading. Bridges designed in this way, however, have failed to attain the desired result. The weak spot is in the floorbeam connection. It is impracticable to construct a floorbeam connection that will transfer overturning moment, such as is delivered from the top chord to the floorbeam without knee-bracing. Does it not seem more reasonable to spread the base of the post, or in other words, the points of support of the top chord, to some proportion of the distance from top chord to floorbeam?

*Bridge Engineer, Michigan State Highway Department, Lansing, Mich.

FIG. 2. PINE RIVER BRIDGE, MICHIGAN

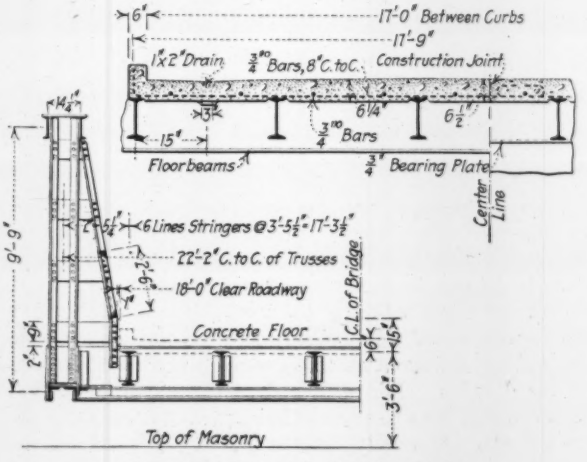


FIG. 3. DETAIL OF KNEE-BRACE

The advantages of this construction are many. Sidewalks may be added without interfering with the design. The bridge is improved in general appearance, and the cramped uncomfortable feeling of driving too close to the truss members is relieved. The lower chord and pedestals of the bridge are far enough away from the roadway so that they do not catch the drip and dirt. On account of the trusses being farther apart, they may be erected outside old-style trusses without interfering with traffic (see *Engineering News*, Oct. 26, 1916).

Finding Leaks and Weaknesses in Baltimore Water Mains

For the last few years the Water Department of the City of Baltimore has been conducting extensive investigations of the condition of underground structures along the city streets. The object is twofold: (1) To repair leaks and save water and (2) to replace old and weak pipes with new ones before improved pavements are laid.

Formerly the method was to tap a pipe at various points and with pitot tubes measure the pressure and the velocity of water flowing and thereby the volume. With all house connections closed between the points tapped the difference between the volumes determined by the pitot tubes gave a measure of the leakage.

It is now the custom to close all valves on a section of pipe to be tested and, with a triplex pump attached to the line, to subject it to a water pressure of 300 lb. per sq.in. If the pipe breaks, it is immediately replaced, thus saving the expense of ripping up improved paving a few years hence when the pipe would have eventually broken. A measure of leakage is also gained by this method by noting the drop of pressure per unit of time in the length of pipe tested.

An "aquaphone" is used to detect the location of leaks; and with this instrument, which consists of a telephone receiver attached to an iron rod, a leak can be "spotted" within 10 ft. The skin friction of water escaping at a leaky joint causes a slight hammer on the pipe, which can be heard in the receiver of the aquaphone when the end of the rod is placed on a fire plug or water box connected to the pipe. The location of the leak is detected by noting the increase of sound as the instrument is applied to the pipe along its length. Water Engineer Lee is at present working on a method whereby the location of leaks may be exactly determined, thus effecting a saving in excavation required to repair the point of leakage.

Construction Features Used by Concrete Building Firm

The Ferro Concrete Construction Co., of Cincinnati, Ohio, one of the oldest reinforced-concrete building firms in the country, has standardized methods of construction in its concrete building work. For the American Tool Works' plant new building in Cincinnati it is able to apply most of the special features that have been developed. Some of these, particularly the adjustable shores, the flexible-mat supports for slab forms, and the column forms, were devised by J. E. Hodges, one of the superintendents for the company, and were described briefly in *Engineering News*, Apr. 15, 1915, p. 730.

The American Tool Works' new plant is being erected in the low-level district of Cincinnati, directly across the street from the Pennsylvania R.R. station, a siding from which runs along one side of the lot and affords very easy communication for material. The building itself is a flat-slab structure of considerable height and ground area.

The aggregate is stored in large bins at one of the narrow ends of the building (Fig. 1). It is loaded into the bin from gondolas by a derrick equipped with a clam-shell bucket and running on a slightly raised trestle, the tracks on which extend along the whole length of the bin so that the derrick can control any one of three cars while traveling along the wide-gage tracks on the trestle. The cement is stored in a house in the middle of the plot immediately alongside of the concrete mixer and tower. The cement sacks are unloaded from cars on the siding and slid down into the house on inclined planes surfaced with rollers.

An important part of the construction equipment is the shop and sawmill located on the street side of the material bins (Fig. 1). In this shop the special forms are made, the machines being driven by a low-grade-oil engine, which

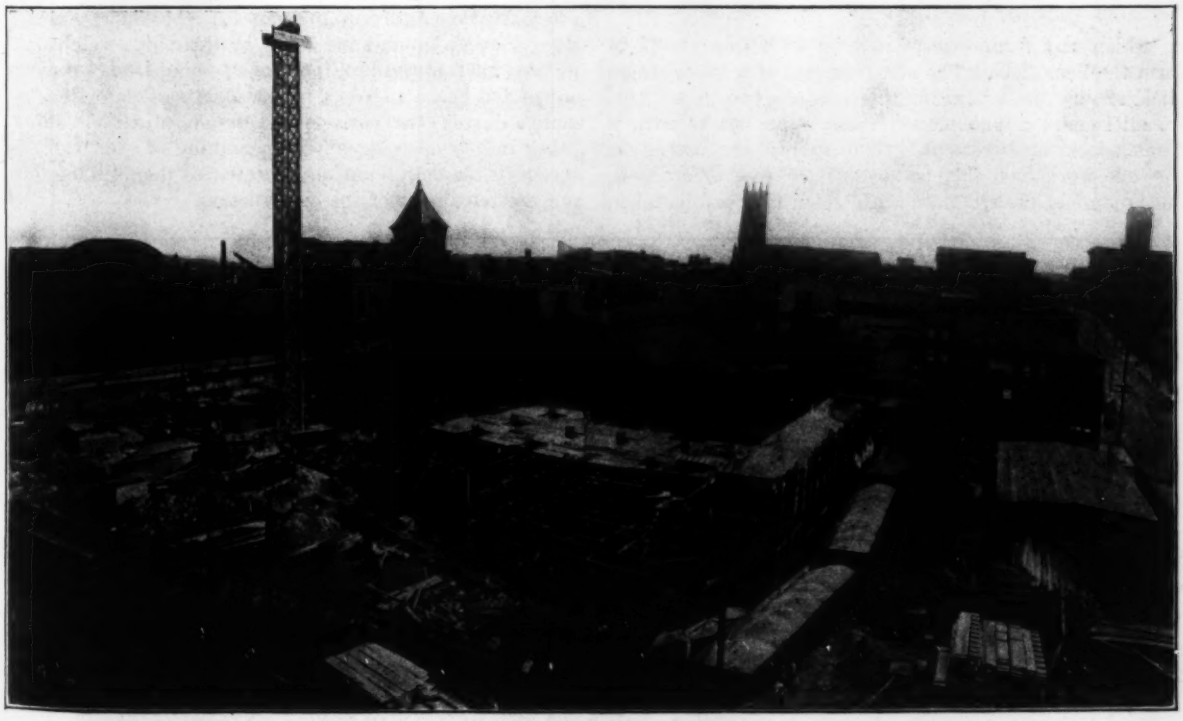


FIG. 1. CONSTRUCTING AMERICAN TOOL WORKS' PLANT AT CINCINNATI

has proved very economical and satisfactory. Inasmuch as a great deal of the formwork is standardized, as will be described hereinafter, the carpenter-shop work can be carried on continuously all during the construction of the building without too much regard for the particular stage of the concrete construction.

The formwork is extremely simple. The elements consist of adjustable shores carrying longitudinal stringers

FIG. 2. FLEXIBLE MAT FOR CONCRETE FORM

on which rest flexible mats covered with iron sheets to form the floor slabs. The strut consists of a lower single stick, about 4 in. square, sliding between two upper 2x4-in. sticks and adjustable on those upper sticks with a ratchet-jack arrangement. The shores are useful in concrete work, not only because of the ease of erection, but because of the readiness with which they can be taken from under the floor forms and placed one by one, to carry the stripped floors. The stringers are spiked to the top of the shores with double-headed nails so as to be easily removed, and on the stringers are rested the flexible mats, one of which is shown in Fig. 2. They are covered with galvanized tinplate, 30 in. wide and No. 24 gage.

The mats are made up of 2x2½-in. sticks so spaced as to permit interlocking of two adjacent mats, the sticks being tied together with wires or chains. They are made on the job or in the shop, as is shown in the view, and can be used over and over again many times. They not only can be made to fit for flat-slab work, but in some special cases they can very readily be curved to fit different types of floor construction. For instance, there is in Cincinnati a garage in which a reinforced-concrete roof is supported on steel roof trusses. The roof surface was built by laying the flexible mats on curved templets, which rested on the upper chords of the roof truss. The narrow inverts in the curves were reinforced with longitudinal rods, forming purlins integral with the roof slab.

In the American Tool Works' building the steel cylindrical column forms previously described in *Engineering News* are used. These are galvanized-iron plates held in position by two bands of round iron, one upper and one lower, drawn together with nuts.

The method of conveying concrete is very well shown in the general view in Fig. 1. The concrete mixer, driven by the steam engine, is located beside a high timber tower in the middle of the lot. Running alongside of the base of the bin and forming a loop around the far side of the concrete tower is a narrow-gage track. This track is so graded that with the aid of a short booster rope section just approaching the tower a car can make the entire round trip under gravity.

The material cars, therefore, are loaded from hoppers in the cellar of the building leading out to the material bin and proceed by gravity to the base of the short incline, where they are pulled up to dump into the concrete mixer. They then go around the tower by their own weight and proceed back to the bin, the cement being loaded directly out of the house adjacent to the tower. This system remains during the entire construction of the building, being in the open lot at the beginning of the work, as shown in the figure, and in the cellar of the building during the remainder of the construction.

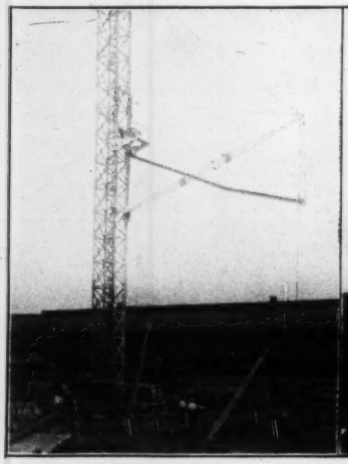


FIG. 3. CONCRETING TOWER WITH SPLIT BOOM

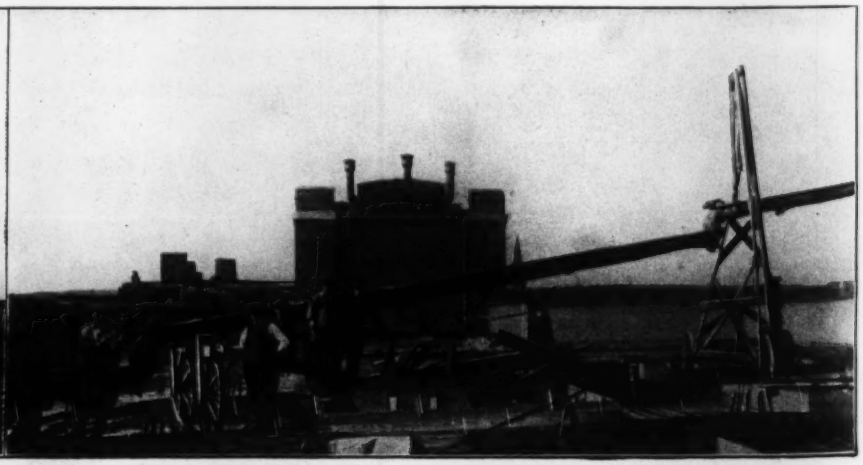


FIG. 4. TRICYCLE AND BICYCLE CARRYING EXTENSION OF CONCRETE CHUTE

Several features of interest may be noticed in the tower and chute delivery system. One of these is the special boom, which is split so as to permit the passage of the chute through it. In some of the original concrete work of this company the boom was made up of separate timbers widely spaced to permit the chute to go through: but in later work, such as the one shown here, the boom is of steel lattice construction wide enough to pass the chute. This chute is movable up and down on the tower by special clamps that fasten onto vertical timber tracks nailed on the uprights of the tower. A lower chute and the lattice boom are shown in Fig. 3. For some kinds of work it is possible, of course, to have two chutes working on the same tower.

For distribution of the concrete to far parts of the building, intermediate supports of chutes must be provided. For this purpose two special carriages have been devised, as shown in Fig. 4. One of these, the higher, which is used to hold the chute when just outside the range of the boom, is a tricycle with a frame from which a block and tackle is hung. The other, used at the extreme end of the chute, is a bicycle. It is a two-wheel truck with a truss frame immediately above the upper range of the tire on which the chute rests. These two trucks are readily movable over the forms even when the concrete reinforcement is in place, so that the chute can be quickly carried thereby to any part of the floor where concrete is being laid.

W. P. Anderson is president of the Ferro Concrete Construction Co., and the work here described is under his general direction, with J. E. Hodges as superintendent.

Asphaltic-Concrete Paving

Specifications for recent pavement work at Fort Wayne, Ind., provide that asphaltic-concrete pavement shall be made with crusher-run stone screenings (hard limestone), of which all must pass a ½-in. screen and 90% must pass a ¼-in. screen. The aggregate must contain 5 to 11% of 200-mesh particles; and if the screenings do not contain a sufficient proportion of this fine material, it must be supplied by the addition of ground limestone or other suitable mineral matter of such density as to produce a powder having a weight of at least 90 lb. per cu.ft. At least 66% of this must pass a 200-mesh screen, and all of it must pass a 50-mesh screen. When thoroughly agitated with distilled water at 68° F., by means of an air blast (avoiding cyclonic effect), not more than 40% must subside on standing for 15 sec.

The material is heated to 300 to 350° F., and after mixing with hot asphalt in a suitable plant the mixture must have from 7 to 11% of bitumen, and mineral aggregate passing the several screens as follows: 200-mesh, 5 to 11%; 40-mesh, 18 to 30%; 10-mesh, 25 to 55%; 4-mesh, 8 to 22%; 2-mesh, less than 10%. This mixture at a temperature of not less than 250° F. is hauled to the street in dump wagons (covered with tarpaulin) and dumped at some distance from the area on which it is to be spread. It is then thrown into place with hot shovels and forks and leveled with the back of a rake ready for the rolling. The rollers weigh 8 to 10 tons and give a finished wearing surface 2 in. thick.

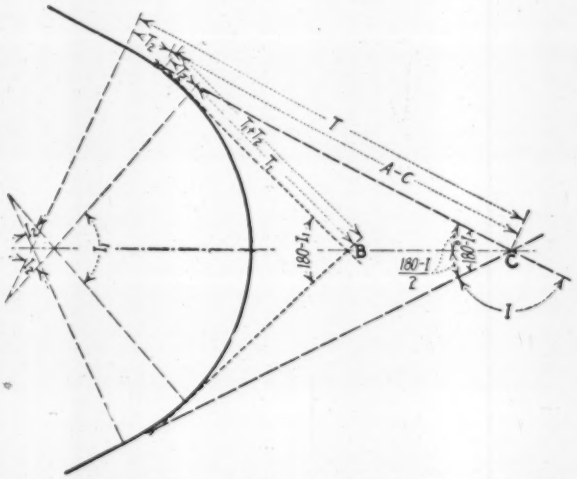
Over the warm surface is spread asphalt cement in sufficient quantity to fill the voids without leaving any excess, and upon this is at once spread a ¼-in. top dressing of fine crushed Wisconsin granite. This is then thoroughly rolled into the asphalt surface.

This city is using asphaltic-concrete paving extensively, and in the past three years has laid about 12 mi. The common practice is a 2-in. top layer on a concrete base, the latter being made 6 in. thick on account of the clay foundation. The surface of this concrete base is left in a rough condition, so as to form a mechanical bond with the asphaltic-concrete wearing surface. This type of paving was designed by Frank M. Randall, City Engineer of Fort Wayne, Ind.

Determining the Tangent of a Compound Curve

By F. L. Beal*

In locating Y-tracks, interchange tracks and other work of a similar nature, it is frequently desirable to connect two intersecting tangents with a curve which is of a different degree than that of the lead of the switch at either end. This requires a compound curve consisting of three simple curves, one at each end from the point of switch to the point of frog and the main curve between frog points. The only difficulty in locating such a curve



DETERMINING THE TANGENT OF A COMPOUND CURVE OF THREE PARTS

is the calculation of the tangent length, which it is necessary to know before the frog points can be located.

In the accompanying plan

I = Intersection angle between tangents;

I_1 = Intersection angle of the curve between frog points;

I_2 = Intersection angle of the lead or the frog angle;

T_1 = Tangent distance of the curve between frog points and is taken from a table of the functions of a 1-deg. curve;

T_2 = Tangent distance of the curve which forms the lead and is also taken from tables.

Now in the oblique triangle ABC we know the following from inspection:

$$Angle\ CAB = the\ intersection\ angle\ I_2$$

$$Angle\ ACB = \frac{180° - I}{2} = 90 - \tfrac{1}{2}I$$

*Valuation Engineer, Louisiana & Arkansas Ry., Stamps Ark.

$$Angle\ ABC = 180 - [90 - \tfrac{1}{2}I + I_2] = 180 - 90 + \tfrac{1}{2}I - I_2 = 90 + \tfrac{1}{2}I - I_2 = 90 + \tfrac{1}{2}I_1$$

Side AB is equal to $(T_1 + T_2)$.

We know that in an oblique triangle such as ABC that the sides are proportional to the sines of the opposite angles, hence we may write:

$$\frac{AC}{AB} = \frac{sin\ (90 + \tfrac{1}{2}I_1)}{sin\ (90 - \tfrac{1}{2}I)},\ \text{or}\ AC = \frac{sin\ (90 - \tfrac{1}{2}I_1)}{sin\ (90 - \tfrac{1}{2}I)} \times AB,\ \text{or}$$

$$AC = \frac{cos\ \tfrac{1}{2}I_1}{cos\ \tfrac{1}{2}I} \times AB = (cos\ \tfrac{1}{2}I_1\ sec\ \tfrac{1}{2}I)(T_1 + T_2)$$

Now since T is equal to $AC + T_2$, we may write the solution thus:

$$T = [\ (cos\ \tfrac{1}{2}I_1\ Sec\ \tfrac{1}{2}I)\ \ (T_1 + T_2)\ ] + T_2$$

⁂

Daily Field Reports on Construction Work

By G. H. Hailey*

The daily field reports used on our construction work are shown in the accompanying forms. These reports are made out by the timekeepers on the work. Each form is 8½x13½ in.

As will be seen, the reports are made daily, on two sheets, the first being the time report and the second the equipment and material report. On the time report the names of the men in the gang, together with their hours and rates, are shown in the lower left part of the sheet. On the first day of each month both the names and the numbers of the foreigners are shown, but during the remainder of the month only the numbers are required. It will be noticed that each man must be accounted for. If one does not work a full day, he must be shown as "discharged," "laying off," etc.

The upper portion of the report contains the classifications of work done during the day, entered by hours under each occupation and extended in dollars and cents to show cost of each classification for the day. The total hours in this part of the report must check with those in the lower left portion. The total cost of each classification from the start of the work is shown in the "Amount to Date" column. In the lower right part of the report is shown the quantity of work performed during the day, covering the items for which there are unit prices in the contract.

The second sheet of the daily report, known as "Equipment and Material Report," contains the daily record of the use of equipment and materials as well as a report of the materials received and shipped during the day. The "Equipment Record" not only serves to give to the general office information as to the location of all larger equipment, but also shows the actual hours of work performed

*Chief Engineer, Cleary-White Construction Co., general railway contractors, 105 West Monroe St., Chicago.

CLEARY-WHITE CONSTRUCTION CO.

A. DAILY REPORT

CONTRACT C. & S.W. R.R. LOCATION Bridge 82 Troy Iowa

CLASSIFICATION OF WORK DONE	Foreman	Foreman	Timekeeper	Water Boy	Cook	Watchman	Interpreter	Carpenter Foreman	Carpenter	Engineer	Fireman	Teamster	Horse & Mules	Pile Driver Foreman	Pile Driver Helper	Skilled Labor	Laborers	AMOUNT THIS DAY	AMOUNT TO DATE
Hour Rate	50		30				30	40	35	40				40	30		25		
Driving Piles	1		1					1	9	10				10	20		30	$39 40	$101 50
Wet Excavation	3		3				5			5							80	32 00	241 60
Building Forms	1		1					9	36								10	13 60	216 40
Concreting	5		4							5							85	26 75	326 90
Unloading Cement							1										18	4 50	39 50
" Sand							1										20	5 00	19 00
" Stone							1										30	7 50	207 40
" Coal							1										25	6 25	32 95
Loading Lumber							1										25	6 25	
TOTAL	10		10				10	10	90	20				10	20		343	$132 75	

TIME STATEMENT

NAME	Hrs.	Rate	NAME	Hrs.	Rate
R.A. Swanson	10	50	T. Costa *134	10	25
A.S. Clark	10	30	W. Rudnick *133	10	25
Tom Lackey	10	40	P. Petrovich *132	12	25
F.E. Webb	10	40	S. Wukel *131	12	25
S.E. Scott	10	40	A. Luba *130	12	25
R.S. Hunt	10	40	T. Provich *126	13	25
J.O. Cook	10	35	Steve Dvil *127	13	25
W.R. Hackney	10	30	W. Revich *128	13	25
A.J. Brown	10	30	Tony Mike *129	13	25
P.E. Humphrey	10	30	P. Prodoff *120	13	25
Joe Mirbe	10	30	S. Nikoff *121	13	25
K. Iverson	10	30	W. Stevich *122	13	25
Steve Pushka	10	30	P. Stanich *123	10	25
Tony Milda *101	10	25	P. Wukoff *124	10	25
J. Nikoloff *102	10	25			
B. Cleanoff *103	10	25			
S. Stanoloff *104	10	25			
W. Nikoloff *105	10	25			
B. Trasha *106	10	25			
G. Velichko *107	5	25	Sick		
P. Stanoff *108	12	25			
J. Nikoloff *109	13	25			
R. Lapoff *110	13	25			
P. Rachoff *111	12	25			
M. Stanoff *112	10	25	Discharged		
Tony Pushka *113	5	25	Discharged		
Steve Dvich *114	10	25			
R. Ivanoff *115	10	25			
W. Stevich *116	5	25	Discharged		
S. Costoff *117	10	25			
S. Petanoff *118	10	25			
P. Trashoff *119	0	25	Laying off		
P. Nikoff *120	10	25			

REVENUE WORK DONE		This Day	To Date	Amount
Dry Excavation	C.Y.		193	
Dry Excavation Between Piles	C.Y.			
Wet Excavation	C.Y.	11	136	
Wet Excavation Between Piles	C.Y.			
Loose Rock Excavation, Dry	C.Y.			
Loose Rock Excavation, Wet	C.Y.			
Solid Rock Excavation, Dry	C.Y.			
Solid Rock Excavation, Wet	C.Y.			
Round Piles in Cofferdams	Lin. Ft.			
Wakefield Sheet Piling	M.B.M.			
Single Row T. & G. Sheet Pile	M.B.M.			
Double Row T. & G. Sheet Pile	M.B.M.		12.65	
Placing Shoring Lumber	M.B.M.			
Single Row Box Joint Sheet Pile	M.B.M.			
Double Row Box Joint Sheet Piling	M.B.M.			
Driving Steel Sheet Piling	L.B.			
Pulling Steel Sheet Piling	L.B.			
Driving Foundation Pile	Lin. Ft.	490	1290	
Placing and Removing Grillage Timber	B.M.			
Placing Concrete	C.Y.	39	406	
Making treatment concrete Piers Slabs	C.Y.			
Placing treatment concrete Piers Slabs	C.Y.			
Placing Reinforced Bash	L.B.			
Rock Filling (100 ft. Free Haul)	C.Y.			
Applying Waterproofing, to Arches	Sq. Ft.			
Applying Waterproofing, to Concrete Slab Plants (including area No.)	Sq. Ft.			
Applying Waterproofing to Concrete Slab Plants Over Stone	Sq. Ft.			
Face Arrasse Work				
Weather and Remarks				
Fair 72°				

R.A. Swanson FOREMAN

A.S. Clark TIMEKEEPER

DATE Sept 1st 1916

CLEARY WHITE CONSTRUCTION CO.

EQUIPMENT AND MATERIAL REPORT

CONTRACT C. & S.W. R.R. LOCATION Bridge 82, Troy Ia

EQUIPMENT RECORD

KIND	MAKE AND SHOP NUMBER	HOURS	REMARKS
Air Hoist & Pump 6"	Morris #612	00	
Hoisting Engine	Lambert 1812	00	
Pile Driver		10	Driving Piles
Hoisting Engine	Corliss #2516	10	Driving Piles
Mixer	Wisconsin #710	5	Concreting
Air Hoist & Pump 6"	Morris #613	8	Wet excavation
Duplex Pump	F. W. #3030	00	Received today

MATERIAL RECORD

KIND	RECEIVED	USED	BALANCE ON HAND	AMOUNT
Cement	600 Sax	136 Sax	3200 Sax	
Sand	34 yds	14 yds	320 yds	
Stone	36 yds	31 yds	680 yds	
Piling	None	22-22' Pieces	18-22' Pieces	
Pumping Pipe	None	None	17600 pounds	

EQUIPMENT AND MATERIAL RECEIVED

KIND	MAKE & SHOP NO.	SIZE	QUANTITY	WEIGHTS & MEASURES	FROM WHOM RECEIVED	INITIALS & CAR NO.	
Coal		Lump	1 Car	40 Tons	A.B. Coal Co	B&O	42400
Cement			1 Car	600 Sax	S. P. Cement Co	Ry & W	32416
Sand			1 Car	34 yds	Drexel Sand Co	C&NW	96480
Stone			1 Car	36 yds	Smith Stone Co	R & A	53060
Duplex Pump	F. W. #3030	3-2-4	1		R.W.C. Co. W. Chgo	Local	Freight

EQUIPMENT AND MATERIAL SHIPPED

KIND	MAKE & SHOP NO.	SIZE	QUANTITY	WEIGHTS & MEASURES	TO WHOM SHIPPED	INITIALS & CAR NO.	
Nat. Cement Sax			1200		S P Cement Co	Ry & W	F32462
Air Hoist & Pump	Morris #348	6"	1		C.W.C.Co. W. Chgo	R&A	42160
Lumber		3x8-16'	140 pcs	4480'	C.W.C.Co. Troy Ia	C&NW	32400

R.A. Swanson FOREMAN

A.S. Clark TIMEKEEPER

DATE Sept 1st 1916

SEPARATE DAILY REPORTS FOR LABOR AND MATERIAL

by each machine; and therefore the expense and efficiency of any particular piece of equipment may be readily determined. The "Material Record" shows the supply of material on hand and also the amount used for the day as a check against both the cost and the quantity of unit-price work performed as shown on the time report. The lower part of this sheet gives the daily information regarding material, supplies and equipment received and shipped.

These reports give complete information regarding the condition of a job and also furnish the figures necessary for the preparation of cost data, not only for the labor expense, but also for the use of equipment and the materials used. No extra expense is incurred in the preparation of these reports, because they are easily made by the timekeepers; and on a contract of any considerable size a timekeeper is required. We have made it a practice to use young engineers for such work, and they have no difficulty in taking the necessary measurements and obtaining the other data required for the preparation of the reports. In case of any "extra work" performed, for which bills must be made, it is a very easy matter to get the expense from the reports. This includes not only the labor, but also the equipment and materials used.

One of the large western railways, for which we are doing some bridge work, after seeing our reports the past season has decided to adopt the form for its own work. Other contractors may have daily report forms better and more useful than these; if so, I should be glad to see some samples published. The samples may be more interesting to engineering accountants than to engineers, but from the standpoint of cost data alone the forms will probably appeal to some engineers.

Station-Men System Succeeds on the Alaskan Ry.

As soon as it was noised about that Anchorage, Alaska, was to be the starting point of construction work on the Alaskan Ry., the population of the town jumped to 2,000. Many of the newcomers were employed at once in handling supplies and construction equipment that arrived on each incoming steamer. These men were hired as day laborers and received a wage of 37½c. per hour, eight hours constituting a day's work. Many of the men working about the material yards were fed at the messhouse for $1 a day. The total force at work at the end of May, 1914, was about 100 men, this number increasing to about 600 in the following summer.

Work Done by Station Men

It had been decided that the most satisfactory method to pursue in the actual construction of the railway, where the work could be classified and contracted for at unit prices, was by the use of station men. Under this method a number of men associate themselves together as partners, taking short pieces of work at a certain price per cubic yard for grading, or per acre for clearing or grubbing.

Scacely any capital is necessary to take a station contract, as the Commission furnishes the necessary equipment at a moderate rental. The men also have the privilege of purchasing supplies at reasonable prices at the commissary established by the Commission. This is not obligatory, however, as they are free to buy where they desire.

The recently published reports of the Alaskan Engineering Commission (covering the period Mar. 12, 1914 to Dec. 31, 1915) state that "the large contractor was eliminated and the station men consequently received more for their work." Their profits have varied according to skill and experience. The average gross wages received by 46 station gangs on grading was 41c. per hour per man; the gross wages received by 31 gangs on clearing work was 60c. per hour per man. Gross wages are wages earned after making all deductions for cost of tools, explosives, team hire, outfit rentals and hired labor, but not subsistence. The number of men on station work fluctuated from 400 early in June, 1915, to 724 in the latter part of July of that year.

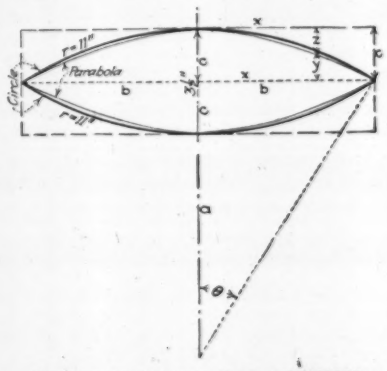
Contract Prices and Cost of Construction Materials

All material removed in grading was classified under one of the three following heads: Solid rock, loose rock and common excavation. The prices paid were: For solid rock, 75c.; for loose rock, 32 to 35c., and for common, 25c. per cu.yd. Where material had to be hauled in excess of 400 ft. an additional price of 1c. per cu.yd. per 100 ft. was paid.

For clearing the right-of-way the price ranged from $30 to $75 per acre, depending upon the character and density of the timber. For piling and culvert timbers 10 to 15c. per lin.ft. was paid. The native timber was cut into ties, these costing the Commission 35 to 37c. each, delivered at Anchorage or along the line. Lumber for bridges and buildings was imported from Puget Sound, the price varying from $15 to $28 per M ft. b.m. The bridge timbers were framed in the material yard at Anchorage and hauled by construction train to the site.

Finding Moment of Inertia of Lenticular Section

A special computation problem solved by William Vetter, State Highway Department, Springfield, Ill., gives a simple formula for the strength of a lenticular body



LENTICULAR ROCKER SECTION

(in this case a bearing rocker). The method involves some approximation, but should be dependable in all practical cases, especially for flat arcs.

The arcs of the rocker section are circular. Drawing parabolic arcs as shown in the sketch, the moment of

inertia of the parabolic segments is $^{16}/_{35}$ of the moment of inertia of the rectangle that contains them:

$$I = \int_0^b \tfrac{1}{3}y^3 dx = \tfrac{1}{3}\int_0^b \left(\frac{c}{b^2}\right)^3 \times (b^2 - x^2)^3 dx = \tfrac{16}{35} \times \tfrac{1}{3}bc^3$$

Considering both circular and parabolic segments as shown, it is evident that the difference between the radii of gyration is very minute, and the two can therefore be considered equal. (The radius of gyration of the circular segment is probably greater than that of the parabolic.) Therefore, the moments of inertia are approximately proportional to the areas involved.

$$\textit{Area of circular segment} = \pi r^2 \times \frac{\theta^\circ}{360^\circ} - \frac{ab}{2}$$

$$\textit{Area of parabolic segment} = \tfrac{2}{3}\, bc.$$

Substituting the values $r = 11$ in., $b = 5.95294$ in., $c = 1\frac{3}{4}$ in., $a = 9\frac{1}{4}$ in., and $\theta^\circ/360^\circ = 0.091$, there results:

$$\textit{Area of circular segment} = 7.05981 \textit{ sq.in.},$$
$$\textit{Area of parabolic segment} = 6.91178 \textit{ sq.in.}$$

also:

$$\textit{Ratio}\ \frac{7.05981}{6.91178} = 1.02142$$

The moment of inertia of the parabolic segment $= {}^{16}/_{35} \times \frac{1}{3}\ bc^3$.

Substituting in this formula the values given above, we have:

$${}^{16}/_{35} \times \tfrac{1}{3} \times 5.95294 \times (1\tfrac{3}{4})^3 = 4.86155\ in.^4$$

whence the moment of inertia of the four parabolic segments is

$$4 \times 4.86155 = 19.4462\ in.^4$$

and the approximate moment of inertia of the circular rocker section is

$$19.4462 \times 1.02142 = 19.86\ in.^4$$

In case the ends of the rocker should be cut off, it is necessary to subtract from the moment of inertia of the remaining figure the moment of inertia of the two end areas which may be considered to be triangles.

FINE AGGREGATE

An Unusual Engineering Term—The Watertown-Newton boundary line and the Brookline-Newton boundary line were perambulated on Aug. 4 by committees representing the town of Watertown and the town of Brookline and a committee representing the city of Newton of which the city engineer was a member.—Report of the City Engineer of Newton.

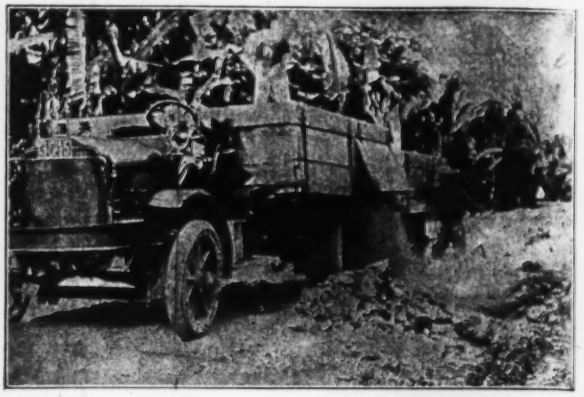
Field Determination of Bridge Skew—Willis Whited, Bridge Engineer, State Highway Department, Harrisburg, Penn., writes that in reconnoissance work for ordinary highway bridges no great accuracy is required in determining the skew; even a variation of 5° being seldom important. The method of determining this skew, in the field, which Mr. Whited has employed for a number of years, is to take an ordinary 6-ft. rule, hinged about its 3-ft. joint, place one arm in the line of the road and the other arm in the line of the stream; the distance between the two ends is the chord of the angle of skew of the bridge. The following is a table by which the angle can be determined:

Radius equals 36 in.

Chord	Angle	Chord	Angle
18 in.	29° 00′	36 in.	60° 00′
20 in.	32° 20′	38 in.	63° 40′
22 in.	35° 40′	40 in.	67° 20′
24 in.	39° 00′	42 in.	71° 20′
26 in.	42° 20′	44 in.	75° 20′
28 in.	45° 40′	46 in.	79° 20′
30 in.	49° 20′	48 in.	83° 40′
32 in.	52° 40′	50 in.	88° 00′
34 in.	56° 20′		

Intermediate angles can easily be interpolated.

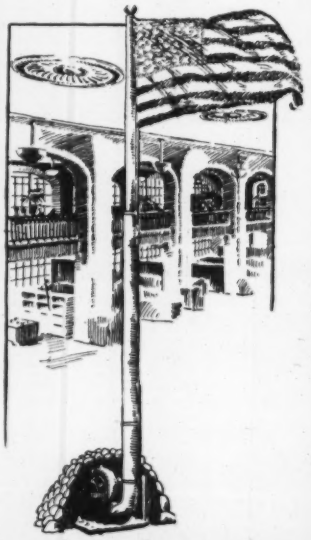
Motor Trucks and Trailers with self-dumping side-hopper bodies have been found best for roadwork in Leyte Province, Philippine Islands. These dump bodies were designed by the district engineer's office (L. T. Clark, Tacloban, Leyte), and have proved more successful than the self-dumping bodies originally furnished with the trucks and trailers, because the stone can be dumped more quickly and also because the material falls in two rows on either side of the road, thus permitting the traffic to pass between the piles. The ordinary



MOTOR TRUCK AND TRAILER EQUIPPED WITH SIDE-HOPPER SELF-DUMPING BODIES

self-dumping body piles the stone in the middle of the road unless much time is taken to back the car so as to dump it on one side. This is often impracticable on account of the narrowness of the road. The new bodies are designed with the floor of sufficient pitch to permit the stone to fall as soon as the sides are unhooked. The whole 7.5-cu.m. load is dumped in about 5 min. Because of adverse climatic and road conditions, few facilities for repairs or of obtaining spare parts, the district engineer considers that these 6-cylinder 60-hp. trucks are too costly, not only from the standpoint of purchase price, but also from that of operation and repair. Also, they and the steel-tired trailers do too much damage to the road. The 4-cylinder 40-hp. truck with rubber tires, however, has proved a success. It hauls more, partly because it does not have to be laid up when it rains, and hauls at a cheaper rate both per kilometer-cubic meter and per kilometer run. A charge of 15c. per km. run in 1915 resulted in saving $897, while with a 6-cylinder truck it has been necessary to make a charge of 30c. per km. run to meet all expenses.—July "Bulletin" of the Bureau of Public Works, Philippine Islands.

Artificial Breeze Waves Flag—The spectacle of a flag waving from its staff in a seemingly quiet atmosphere was presented at the recent Atlantic City convention of the American Electric Railway Association. It was a part of the exhibit of the General Electric Co., and how it worked is seen from the accompanying sketch. The pole was a tapered tube 27 ft. high, 9 in. in diameter at the bottom and 5 in. at the top. The bottom terminated in an elbow set on the outlet of a 2-hp. motor-driven blower. For 9 ft. down from the top of the tube were two rows of ½-in. holes 1½ in. apart and on either side of the flag. With the blower going, the jets from these holes kept the flag waving. The blower and pole base were inclosed in a box covering. The effect of the flag was heightened by lighting it from projecting lamps on either side of the hall. This would be an effective decoration for any large convention hall or exhibition, and it is not unlikely that it will become a familiar scene at such affairs.



FLAG WAVED BY ARTIFICIAL BREEZE

Editorials

Engineering News Prize Offer for Short Articles

The attention of readers is again called to the offer of prizes made in *Engineering News* of Oct. 26 for the best short articles on four selected engineering subjects in four different fields of engineering work. As was there stated, the sum of $300 is offered in prizes, there being four first prizes of $50 and four second prizes of $25, while articles not receiving a prize but accepted for publication will be paid for at the rate of $10. The four subjects selected are in the fields of road construction, rock drilling, concrete work, and motor truck transportation, all of them fields in which a very large number of engineers are actively at work at the present time and in all of which new developments are constantly appearing.

Letters have been received by *Engineering News* since the announcement of the prize offer inquiring whether articles written for the competition should describe actual operations at one specific place, or whether articles discussing the subject generally are desired. Since others may have had similar questions in mind, it may be well to say that either class of article is acceptable for the competition. The decision as to merit will be made regardless of this particular distinction although it would appear that generalizations can hardly be kept down to the minimum of 1,000 words.

One of the motives which has influenced the editors in making this prize offer is to encourage the writing of short technical articles, describing results of actual experience, by the men who are actually engaged in construction work and who often, through contact with practical problems, obtain information that deserves to go on record for the general benefit of the profession.

There are always available for publication in *Engineering News* long, elaborate articles which take up a large amount of space and, if accepted, necessitate the crowding out of other matter more condensed in form. There is on the other hand almost always space for prompt publication of the article by a contributor who has something important to say and who can say it in brief, concise form.

We do not mean by this to decry the value of the long and elaborate monograph in technical literature. Such papers have their place; and the funds of the engineering societies are well utilized in printing such papers and making them available to the profession. The technical journal, however, in order to adequately cover its field, must keep its readers posted on the new developments all the time going on in the various departments of engineering work and must give preference to the shorter articles which tell the story in a condensed form which the busy engineer will find time to read.

As announced in the offer, the competition will close on Dec. 10. The brevity specified for the articles, none of which are to exceed 1,000 words, makes it easy for engineers who may not have seen the previous announcement of this prize offer to undertake their preparation of articles now and send them in before the competition closes.

Blundering Road Legislation in New Jersey

The voters of New Jersey gave a large majority, at the election of Nov. 7, in favor of approving the Eagan bill, which was enacted by the last legislature and provides a bond issue of $7,000,000 to raise money for state highway improvement. The large majority in favor of the bill is not surprising, for the measure was placed before the voters as practically a panacea for the road troubles from which New Jersey is now suffering, and very few of the voters were aware of the serious defects in the bill. These defects are not at present important, however, for the attorney-general of the state has rendered an opinion that the provisions of the Eagan bill cannot be carried into effect because it specifies certain work to be performed and provides an appropriation far below the estimated cost of the work. On this account the bill is rendered null and void by another statute of New Jersey.

The Eagan bill provides for a $7,000,000 bond issue to build 555 mi. of roads located in various parts of New Jersey. The bill specifies that these roads are to be paved with granite, asphalt or wood block, brick, concrete, bituminous concrete, asphalt "or other pavement having a hard surface and of a durable character"; the width of the pavement is to be at least 18 ft., and the total width of the roadway at least 30 ft.

Dividing $7,000,000 by 555 shows that the permissible expenditure on these roads would be less than $13,000 per mile. With a minimum width of 18 ft., there would be at least 10,560 sq.yd. of paving to be laid per mile; and of the materials specified as permissible for the paving, concrete is the only one that could possibly be brought within this limit of expense, even if the entire sum available were to be expended on the paving alone.

As any engineer with even an elementary knowledge of road building and road reconstruction is aware, there is a great deal of work and expense involved in road reconstruction aside from the paving. Col. Edwin A. Stevens, State Road Commissioner, in a report to Governor Fielder last August, estimated that to build these roads in accordance with the specifications laid down in the law would cost in the neighborhood of $16,000,000.

The voters of New Jersey, in approving the Eagan bill, were doubtless under the impression that they were providing a very large sum of money, sufficient to solve New Jersey's road problem. The investigations of the State Chamber of Commerce, however, show that in 1914 the state with its counties and towns spent over $7,200,000 on road construction and maintenance, and the annual expenditures have materially increased since then. Further, whereas the Eagan bill only provides for the improvement of thirteen specified through routes with an aggregate of 555 miles, there are in the state over 9,000 miles of improved roads, a very large proportion of which are in such bad condition that they need thorough repair.

The one ray of light in the situation is that a state commission was appointed some months ago, as announced in

Engineering News, to study the entire New Jersey road situation and outline the proper policy for the state to adopt. That commission is still to make its report, and it is to be hoped that it may deal with the road question with better understanding than did the framers of the Eagan bill.

More Evidence of Unreliability of the Stronger Bronzes

Just two years ago, in *Engineering News* of Nov. 26, 1914, there was published a review of the disquieting experiences that the engineers of the Catskill Aqueduct had had with some bolts, rods and other rolled materials of high-strength bronze, such as manganese bronze and tobin bronze. These high-strength bronzes had their origin in a series of researches carried out by the late Dr. R. H. Thurston while he was connected with the Stevens Institute some thirty years ago. They have approximately the strength of soft steel, and because of this high strength and their freedom from corrosion they have been very widely used for a number of years in many fields of engineering construction.

In the large control works in connection with the Catskill Aqueduct construction, extensive use was made of these high-strength bronzes. It was not until some suspicious cracks were found in some of the rolled material that any doubt was entertained as to their reliability. Extensive investigations and tests carried out under direction of A. D. Flinn, Deputy Chief Engineer, following this discovery showed that all classes of rolled material of these bronzes were more or less unreliable, while forgings and castings appeared to be unaffected. The failures of the rolled material were so numerous and extensive as to cause the gravest apprehension. Hundreds of bolts broke at one time or another when under tension, and bolt heads snapped off. New bolts that had never been used or placed under stress and were still in the packing cases in which they were shipped were found cracked and broken. Some ¼-in. flange plates inspected after manufacture and found then in good condition were examined a few months later and showed serious cracking.

Comparatively little has been heard of similar trouble elsewhere with these bronzes, although Mr. Flinn's investigations disclosed that something of the sort had been experienced in Germany and investigations had been made in the Government testing laboratories in Berlin.

The annual report (just issued) of Gen. George W. Goethals, Governor of the Panama Canal, discloses that serious trouble has also been experienced at Panama with the large manganese-bronze bolts used to support the counterweights on the spillway gates. General Goethals says:

> On Oct. 10, 1915, the counterweight of spillway gate No. 13 at Gatun gave way and dropped into its pit, demolishing all weights. This machine had not been operated for several days and was not being operated at the time of the accident. On investigation it was found that all four manganese-bronze counterweight bolts had given way.
>
> Each spillway counterweight consists of 56 cast-iron blocks weighing 750 lb. each, resting on a cast-iron base plate and supported by four 1¾-in. manganese-bronze bolts running into a cast-steel yoke at the top. The total weight of the counterweight is 45,700 lb. and assuming that the load is equally distributed, each bolt supports 11,425 lb., or a stress of 4,750 lb. per sq.in. of metal. Sections of the bolts were sent to the mechanical division for test, which gave an ultimate tensile strength of 61,400 lb. and 63,900 lb. per sq.in., respectively, for the two bolts tested. This would indicate a factor of safety of about 13.
>
> All guard-gate counterweight bolts were examined and instructions given to replace the defective ones with steel bolts. An examination of the Miraflores spillway counterweight bolts resulted in finding two bolts broken off at the head and others with surface cracks, indicating probable failure. All counterweight bolts of the spillway-gate machine have been replaced with steel, and bronze bolts are being replaced with steel wherever failures occur.

Surely if these high-strength bronzes are liable to such failures, engineers need to be on their guard, not only as to the use of these materials in new construction in places where their failure might cause disaster, but to inspect carefully any structures under their charge which may contain these materials that may possibly be in a condition of incipient failure.

The investigations that were made by the Board of Water-Supply Engineers failed to reveal any method of inspection or test which would distinguish between bronze that was sound and reliable, and material that was on the point of failure. These failures were not confined either to any one brand or make of the bronzes examined, indicating that reliance could not be placed on the methods used by any particular manufacturer.

That the mystery in connection with the inexplicable failure of these materials will eventually be solved can hardly be doubted. The value to engineers of a material of such high strength, which is at the same time resistant to corrosion, is so great that the facilities of the best research laboratories ought to be devoted to the task of solving this problem.

The copper industry has been experiencing such a period of phenomenal prosperity and unlimited demand for its product during the past two years that nobody has cared particularly whether the market for copper in the form of these strong bronzes was seriously impaired or not. Present conditions in the copper industry, however, cannot possibly be permanent. Some of the firms that have made such large profits in the copper business during the past two years can well afford to appropriate an insignificant percentage of these profits to find out how the strong bronzes can be so manufactured as to be reliable.

Cost-of-Service Water-Meter Rates to the Front

After several years of committee investigation and convention discussion, the New England Water-Works Association has recommended a particular form of metered-service rate for general use by water companies and departments. Bills made up in the approved way will show a fixed service charge depending on the magnitude of the consumers' requirements plus a variable quantity charge depending on the reading of the meter. The adoption of this standard, studied in connection with the related discussions and reports of the association, is of particular interest and import, indicating as it does the apparent acceptance by a large organized group of water utilities of the idea of a cost-of-service basis for making rates. A big and important step has been taken—an advance has been made from which retreat is unbelievable. For this progress great credit is due to the New England Association's Committee on Meter Rates, under the leadership of Allen Hazen.

The committee has been honorably discharged, but let no progressive water-works man think that cost-of-service rates have been actually inaugurated. The present action is more like a nomination, with the election yet to come. The empty shell of cost-of-service rates has been accepted;

to make the idea a living reality, the figures which are to fit the blank spaces provided must be arrived at by adequate accounting, if the manager is going to do anything more than make the most unscientific division of total expense by number of customers or pumpage. Adequate accounting means standardized accounts, fashioned after the general form adopted for other utilities by a multitude of state regulation commissions which desire to know what each service costs each class of customer. The imposition of such standard accounts would have been forced on the water industry long ago, had there been the same degree of regulation over these municipal departments and companies as is imposed on gas and electric services.

The New England Water-Works Association has done little with standardized accounts beyond appointing a committee, but the door to this field has now swung open through the disposition of the rate-schedule puzzle. We may expect to see standardized accounting loom up larger on the association's horizon as its next great task. A peculiar situation arises: The New England Association has accepted the two-part rate basis and has neglected the standardized accounting required to back it up. The American Water-Works Association has probed the depths of the accounting problem, but has paid little attention to the most important end of good bookkeeping—true scientific rates. Which will consummate the development first?

A Suggestion for Making Water Rates

When the New England Water-Works Association at its November meeting adopted the combination of service and meter charges as the recommended basis of metered-service water rates, it also apparently adopted, but only as a pertinent suggestion, a scheme for computing the service charge by adding to a price per 1,000 gal., first 10% of the cost of the meter and service pipes (where the company and not the consumer paid for these), then $1 per year for meter reading, billing and collecting, and finally $2 to $120 for unregistered water.

That was an excellent suggestion—so far as it went. It remained a mere suggestion and did not attain the dignity of a strong recommendation, as it apparently did not meet universal approval. It probably would have been widely applauded and thoroughly promulgated as a part of the adopted two-part rate scheme if it had been only a little broader. It evidently failed to meet all conditions of water-works operation, and it obviously was a particular case of a broader and more general statement that can be made. We venture to make that generalization here and urge that something like it be mentally attached to the two-part scheme:

Compute the service charge by adding to a price per 1,000 gal. or 100 cu.ft., first X% on the cost of the meter and service pipes where owned by the company, then Y% on the cost of equipment required to meet the peak-load demand of the customer, then $\$Z$ for meter reading, billing and collecting, and finally $\$A$ to $\$B$ for unregistered water.

The reasons for such a suggested procedure need little exposition. There are two kinds of water-works: (1) The product-dispensing type, which pumps at a small steady rate, or collects as nature furnishes, and delivers out of adequate storage at varying rates; (2) the service type, which maintains pump pressure all the time and has power apparatus enough to meet its peak-load demands. For the first type of water company the Y% mentioned above becomes insignificant—even disappears, for the peak-load equipment consists only of a possible addition to diameter of mains, and even this may be absorbed in the provisions for fire protection.

Paying attention to the Y percentage in the case of the service type of water-works automatically clears away much of the worry about manufacturers' rates. If an industrial customer does not draw during peak-load hours, Y may disappear so that an attractive rate can be made to him that will still render a respectable profit to the water-works—or, where profits are not sought, at least make a more continuous use of plant and increase the spread of investment charges. This would be a development parallel to the success of electric central stations in building up off-peak commercial loads.

It would be superfluous to attempt here any more detailed application of the suggested scheme. Suffice it to say that it is not an original or a novel or an untried experiment—it is a scheme broadly applied in public-utility fields today and universally satisfactory to customer and utility alike.

Engineers and Federal Water-Power Legislation

If Congress before the close of the coming short session passes legislation, in a form sufficiently favorable, there will probably be constructed in the next three to five years water-power development amounting to between one and two million horsepower on navigable rivers and on power sites in the far West. This work is of great importance to American engineers engaged in water-power engineering, to other engineers engaged in the manufacture of water power and electric machinery, and to still other engineers engaged in work in which this vast amount of power will be utilized. The extent to which the interests of engineers are dependent on this legislation ought to be understood by all members of the profession, as well as by those whose bread and butter is at stake.

There is no dissent whatever from the proposition that it is very greatly in the public interest that this water-power development shall take place. So far as this source of power is to be utilized to replace power developed by the burning of coal, it operates to lessen the draft on our coal resources and to conserve a gift of nature which once used up can never be replaced. So far as this power is applied to new uses, it will aid in developing new industries, and particularly the chemical industry, whose importance to the national welfare has come to be understood during the past two years as never before.

Everyone knows that Congress was unable at its last session to reach an agreement upon the terms of the bills proposed for enactment to permit this water-power development to go forward. It has been announced that these bills are among the measures which will be taken up and pushed for passage at the coming short session; but the scanty time available, aside from that necessary for the regular appropriation bills, makes their passage extremely doubtful unless strong pressure is brought to bear upon Congressmen so that they may understand the extent to which this legislation is supported by public opinion.

Unless Congress does enact Federal water-power laws at this session, it will probably be years before any such

legislation will be possible. The new Congress will not assemble till a year hence. When it does meet its complexion will be so evenly divided politically that there will be little probability of any bill being passed to which there is any considerable opposition. It is always vastly easier to defeat a bill than to secure its passage, even when majorities are not so thin.

There has been a widespread expression of opinion on the part of engineers during the past few years that the profession should take a greater part in public affairs and especially in those where technical matters are involved and in which the interests of the profession and the public are at stake. Many have urged in the strongest terms that the engineering societies should take action to further legislation of importance to the profession.

No better opportunity could be found for the engineering profession to transform words into deeds than the present. While the individual engineer is as a rule powerless to do anything, except where he may happen to have a personal acquaintance with some member of Congress, there is no doubt whatever that proper representation by the engineering societies at Washington, if the work is done in the right way, may have an important influence in securing properly framed legislation.

The national engineering societies are already moving in the matter. The American Institute of Electrical Engineers has for years had a standing committee on water-power legislation, which has repeatedly visited Washington and appeared before Congressional committees. The American Society of Civil Engineers has recently appointed a similar committee with authority, we are informed, to go to Washington and spend whatever time is necessary there to secure results. It may reasonably be expected that the other national engineering societies, many of whose members have interests at stake quite as great as the members of the Civil and Electrical Engineers, will likewise appoint similar committees.

There is no doubt that such committees will welcome the aid by formal resolutions or otherwise, of state and local engineering societies which may not be able to send delegates to appear before Congressional committees. The more nearly those who go to Washington on this errand impress upon Congress that they represent the united voice of the engineering profession, the more likely will be their success.

We need not take space at this time to discuss in detail the provisions of the pending bills and the arguments that have been made in opposition to them. The thing that should be clearly understood is that the ground of the opposition is not that legislation which will permit water power development is undesirable, but that the legislation now framed gives greater privileges to those who undertake water-power development than are necessary in order to secure the investment of capital. On this matter the unbiased judgment of independent experts should be helpful to a wise solution.

It ought to be more generally understood that in the Federal water-power bills now pending the Government parts with no perpetual franchise, but only grants a 50-year lease. The detailed conditions of this lease are a fair subject for argument, and opinions may reasonably differ. It is certain, however, that the legislation as finally enacted must lay down conditions sufficiently attractive to induce the investment of capital, or it will wholly fail of its purpose.

It must not be overlooked in this connection that with all the nations of the world bidding for the money of American investors, opportunities are open to them to earn a high rate of interest by the purchase of foreign bond issues. The promoter of a water-power enterprise who competes for capital in the investment market must have something substantial that will combine reasonable safety and opportunities for good profits or the so-called public water-power sites will continue unimproved.

Letters to the Editor

Queens Incinerator Tests

Sir—In your issue of Sept. 28, 1916, there appeared an article on the refuse incinerator for Queens Borough, New York City, by J. C. Woodman, of the Decarie Incinerator Co. In so far as this article is an expression of the personal views or opinions of Mr. Woodman, no criticism is offered; but when he presents certain tabulated results of the incinerator tests as the official statement of the committee that supervised the tests, he is misstating the facts. The committee in question, of which the writer was a member, did not as a whole tabulate the results of the tests in its report. Each member of the committee secured his own data, and since these complied with the requirements of the guarantee, signed a report to the architect which reads in part as follows:

> That thereafter, on May 8, 1916, one unit of the said incinerator digested 50 tons of refuse and garbage of the proper proportions within the contract period and at costs within the guarantees. On May 10, 1916, the second unit of the incinerator disposed of 50 tons of garbage and refuse within the contract time and at costs less than those specified in the agreement. On May 15, 1916, both units of said incinerator were operated and consumed 100 tons of garbage and refuse within the contract period and within costs of those provided in the agreement.
>
> We therefore certify to you that the said incinerator and appurtenances meet the requirements of the guarantees provided in the said contract and the said supplemental agreement.

Inasmuch as the tabulated results set forth in Mr. Woodman's article differ considerably from those obtained by a majority of the committee, objection is made to the statement that the results shown in said article are the official expression of the committee as a whole.

CHANDLER WITHINGTON,
Chief Engineer,
Department of Finance, New York City.

New York City, Oct. 9, 1916.

[Proof of Mr. Withington's letter was submitted to Mr. Woodman. The comments of the latter follow.—Editor.]

Sir—When I prepared my article on the Queens Borough incinerator, I knew that no tabulated results were included in the official report of the committee named by

Mr. Withington. I did not intend to convey the idea that the results as tabulated by myself from observations taken by myself were those obtained by the different members of the committee.

In saying that these were "results of the official test made under supervision of a committee of the Board of Estimate of New York City" I meant that these were results obtained while they were present and not necessarily the results that the committee embodied in its report.

I wish to add that, so far as the results go, I am prepared to operate this plant under the conditions stated in the guarantees, at any time, and can produce results as good if not better than those tabulated in my article.

J. C. WOODMAN,
Supt. of Construction, Decarie Incinerator Co.
New Orleans, La., Nov. 3, 1916.

Should Engineers Take Part in Politics?

Sir—About ten days before the presidential election, the writer received by the same mail two communications that caused a considerable shock to his professional sensibilities. One of these communications was an appeal signed by 13 prominent members of the American Society of Civil Engineers in New York, urging the writer to join a politico-engineering club and contribute $10 thereto, to promote the election of Judge Hughes as President of the United States. The other was a similar appeal from a prominent member of the society in Chicago, in the interest of President Wilson's candidacy.

Up to this time the engineering profession, as such, has held itself aloof from the mad and brutal scramble for political "loaves and fishes" that has been going on all over the country, occupying a more exalted plane and looking with dignified "neutrality" upon the activities of partisan politics. The great "American Society" in especial, was regarded by the writer as a serene haven of peace and purity from the polluting influence of politics and politicians. I have often used this expression in talking to younger engineers, that there can be no such thing as a political engineer, because when an engineer becomes a politician he ceases *ipse facto* to be an engineer.

Clarksdale, Miss., Nov. 11, 1916. T. G. DABNEY.

[To avoid possible misunderstanding, it may be well to emphasize that the engineering society named did not as a society take any part in political activity. Any action by members of the society of the sort mentioned, must have been taken as individuals.—Editor.]

Is Passing Examinations To Be the Chief End of Man?

Sir—I understand that the Civil Service Commission of an important city has announced an examination of candidates for appointment as Civil Service Examiner in Mechanical Engineering. A few years hence we shall doubtless hear of examinations to test the qualifications of the candidates who are to examine the examiners! No doubt the civil service laws have been of enormous benefit in replacing appointment for political pull with appointment for capacity and ability; but the best friends of the civil service system are those who clearly recognize the limitations to its useful application. C. S. MERIT.

Early Asphalt Pavements

Sir—In connection with the early use of asphalt in the construction of pavements, referred to in *Engineering News*, Sept. 7, p. 434, I think that you are mistaken in inferring that any asphalt pavements of the modern type were constructed before DeSmedt's experiments in the seventies of the last century.

All the earlier pavements were of an asphaltic mastic composition; that is to say, a material in which the amount of bitumen present was greater than that which was sufficient to coat the particles and more than enough to fill the voids of the aggregate.

This is evident from the descriptions of the use of asphalt in pavements given in Halleck's publication on "Bitumen," 1841, in which it is stated:

> They mixed together the mineral tar and sand; second, mineral tar and lime, slacked by immersion; third, mineral tar, sand and lime.

From the context it is evident that the reference here is to a type of mastic and not to a sand mixture such as was devised by DeSmedt in attempting to lay a pavement that should be a substitute for the rock-asphalt pavements of continental Europe. CLIFFORD RICHARDSON.

New York City, Oct. 25, 1916.

Some Heavy Rainfall

Sir—The very remarkable precipitation at Altapass, N. C., July 15-16, reported (*Engineering News*, Nov. 9, 1916) by Prof. Alfred J. Henry as 22 in. in 24 hr., if correctly stated, is believed to surpass previous records for the United States by a wide margin and perhaps lends color to a severe downpour that was reported by the Maryland Climate and Crop Service as occurring July 26-27, 1897. Although, as I recollect, no rain gage was available, the evidence indicated a precipitation in this storm of 14.75 in. in 18 hr. To confirm the report a special inquiry was made by the Climate and Crop Service, and the result was published by the United States Weather Bureau in December of that year. Heavier downpours are, however, on record:

Place	Date	Inches	Period
Nedunkem, Ceylon	Dec. 15-16, 1897	31.76	24 hr.
Genoa, Italy	Encyclopedia Britannica.	30.0	26 hr.
Gibraltar	Encyclopedia Britannica.	33.0	26 hr.
Hills above Bombay, India	Encyclopedia Britannica.	24.0	One night
Khasia Hills, India	Encyclopedia Britannica.	30.0	Each of 5 days
Lampehoehoe, Hawaii	Dec. 24, 1901	41.3	28 hr.
Mayport, Fla.	Sept. 29, 1882	13.7	24 hr.
Newtown, Penn.	Aug. 5, 1843	13.0	3 hr.
Concord, Penn.	Aug. 5, 1843	16.0	3 hr.
Bear Valley Dam	Feb. 26-27, 1891	17.0	24 hr.
Sherbrook, New South Wales	Jan. 13, 1911	13.57	1 day
Galveston, Tex.	Oct. 22, 1913	12.19	12 hr.
Galveston, Tex.	July 13-14, 1900	14.35	24 hr.
Galveston, Tex.	July 7-8, 1901	14.1	24 hr.

KENNETH ALLEN,
Engineer of Sewage Disposal.
Municipal Building, New York City, Nov. 13, 1916.

NOTES AND QUERIES

"What Solution Is Used To Make White Marks on Van Dyke Negatives?" is asked by a correspondent. "Is a lacquer or varnish applied after the solution?"

Railway Valuation Reports—In publishing the abstract of the Government valuation report on the Atlanta, Birmingham & Atlantic Railroad Co., it was stated that the company was in a receiver's hands, which was true at the time the valuation was made up as of June 30, 1914. Since that time the company has been reorganized as the Atlanta, Birmingham & Atlantic Railway Co. Through an error in the report as furnished, it was stated that the railway is narrow-gage. The road has always been standard gage.

Slab-Deck Concrete Railway Bridge Over Highway

SYNOPSIS—This bridge has a deck of self-supporting slab spans, the longer spans of which have I-beam reinforcement. Special construction is involved to carry a station platform extending across the bridge.

The type of bridge consisting of concrete bents carrying precast concrete deck slabs, which has been used so extensively on track-elevation work, is being employed by the Rock Island Lines for crossings over country high-

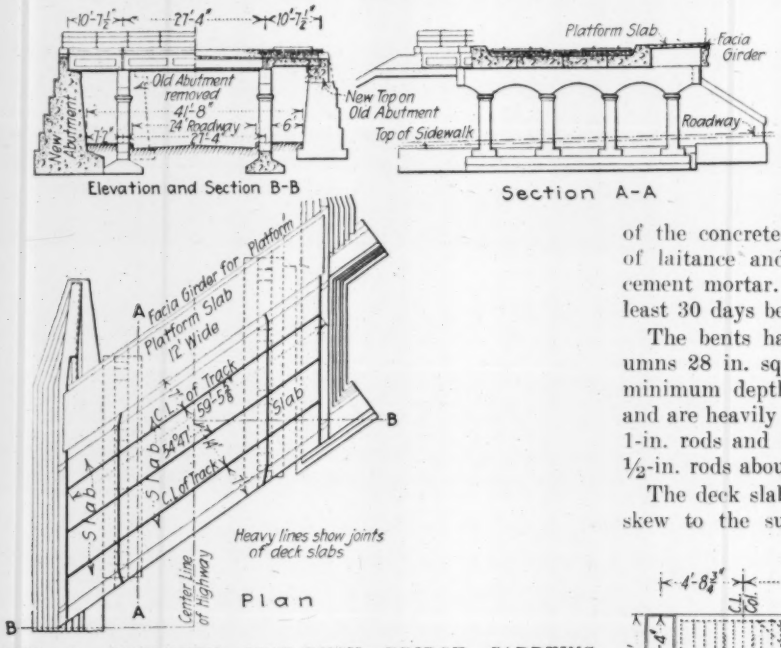


FIG. 1. CONCRETE SLAB-DECK BRIDGE CARRYING TRACKS AND STATION PLATFORM; ROCK ISLAND LINES

ways. The purpose is to avoid the maintenance work required for steel bridges and open timber decks. These concrete bridges are being built particularly where old plate-girder bridges have to be renewed. The accompanying plans represent a typical structure of this class. It provides for a roadway and two sidewalks, as the road in this case is near a town and forms an approach to the railway station. Fig. 1 shows the general design.

The old bridge was a deck plate-girder structure of about 35-ft. span. One abutment is retained (with necessary alterations to the top). The other is to be removed to make way for an additional sidewalk. Inside of each curb line is a concrete bent consisting of four rectangular columns on a continuous footing wall and supporting a cap girder whose lower surface is arched between the columns and at its cantilever ends. The construction and reinforcement of the bents are shown in Fig. 2.

Four lines of slabs form the deck, the slabs of the outer rows having curb walls to retain the ballast. A special feature in this case is that on one side of the bridge an extension of the station platform is provided by a 6-in. slab that is supported on the adjacent track slab and an outer fascia girder, as shown in the cross-section, Fig. 1.

The new abutment is of gravity section, with a stepped back. The face has a batter of 1 in 12 and has a projecting toe beneath the sidewalk. This abutment is about 100 ft. long and is divided by three vertical expansion joints. The sections are keyed together in the joints by a groove 4 in. deep, 8 in. wide on the outer face and 4 in. wide at the bottom.

The concrete is 1:3:5 for the body of the abutment and 1:2:4 for the bridge seat, coping and back wall. The specifications provide that horizontal joints are to be avoided. If it becomes necessary to stop work before completing the section to full height, vertical dowels must be set at the seam in sufficient number to prevent horizontal movement. When work is resumed, the surface of the concrete must be roughened, thoroughly cleaned of laitance and foreign matter and slushed with 1:2 cement mortar. The concrete must be allowed to set at least 30 days before the deck slabs are placed.

The bents have footing walls 7½ ft. wide, with columns 28 in. square and cap girders 28 in. wide with a minimum depth of 3 ft. They are of 1:2:4 concrete and are heavily reinforced. The columns have 16 vertical 1-in. rods and 1-in. dowels to the footings, with ties of ½-in. rods about 16 in. apart.

The deck slabs are arranged parallel to the tracks and skew to the supports, with longitudinal joints on the

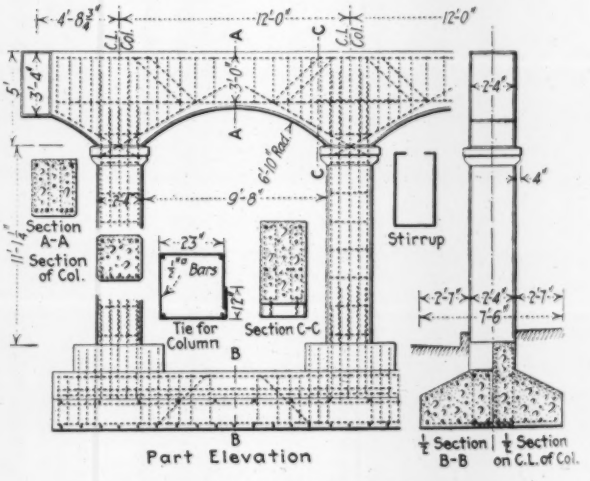


FIG. 2. DETAILS OF CONCRETE BENT

center lines of the tracks, as shown in the plan. They are in four rows, the two outer rows having curb walls to retain the ballast. The outer slabs on one side have a paneled face, but the paneling is omitted on the other side, as this slab is concealed by the fascia girder carrying the station platform.

The slabs for the roadway span are 7 ft. wide, 33½ in. deep at the middle and 31½ in. at the ends, with the facing sides slightly inclined inward. The depth over the curb wall is 55¼ in. These roadway slabs (Fig. 3) are really concrete-filled I-beam spans, since the main structural feature is not the concrete, but a set of 27-in. I-beams, 33 ft. long, spaced 18 in. c. to c. They are thoroughly cleaned of paint, oil and rust before being set in the form. There are transverse bars at top and bottom, and longitudinal rods are laid between the bottom flanges of the I-beams. For handling, each slab has a 2-in. lifting rod; this straddles one I-beam and has the legs bent to fit under the adjacent beams. After the slabs have been set, the tops of the lifting rods will be cut off with hacksaws, so as not to obstruct the waterproofing.

The slabs for the sidewalk spans (Fig. 3) are similar, but without the I-beams. They are 20¼ in. thick at the abutment end, with a rib across the other end to bring

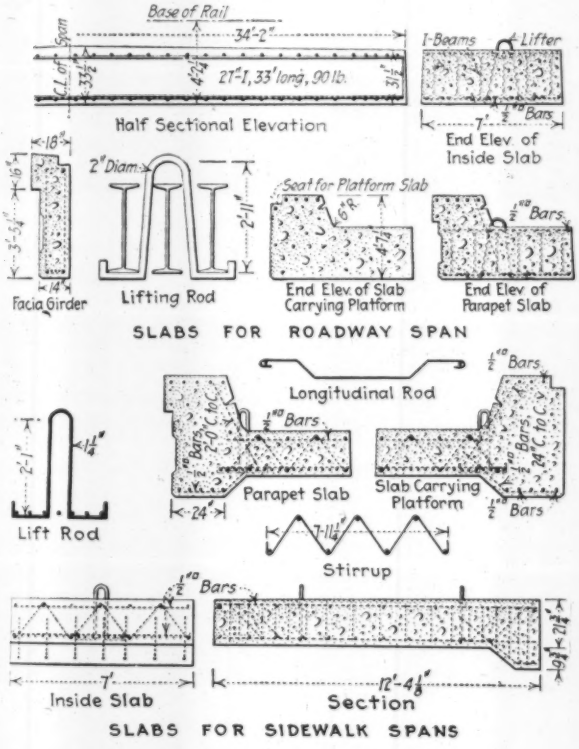


FIG. 3. DETAILS OF DECK SLABS

the top level with the deeper roadway slabs. The reinforcement consists of longitudinal and transverse rods at top and bottom and transverse stirrups bent in V-shape to fit over and under the top and bottom bars respectively. The lifting rods have long bottom flanges extending under the lower reinforcing rods.

The concrete for all slabs is 1:2:4 and must be allowed to set for at least 60 days before the slabs are moved into place. Immediately before placing them in final position the bridge seats and tops of bents must be cleaned, wetted and covered with 1 in. of cement mortar. The fascia girder that carries the outer side of the station platform is built as a continuous girder over the three spans, its total length being 59½ ft. It is 57¼ in. deep and 14 in. thick, with a coping and panels on the outer face, while the top is recessed to form a seat for the platform slab, as shown in Fig. 3. The concrete is 1:2:4. The steel reinforcement consists of horizontal bars at top and bottom, with incline shear bars near the supporting bents and with closed rectangular stirrups. All bars are wired at the intersections. The shear bars are spliced to the horizontal bottom bars, the splices being 3 ft. long and wrapped for the entire length with No. 16 wire. Upon the girder is a gas-pipe hand railing.

The platform slab (like the fascia girder) is in one piece over the entire length of the structure; its length

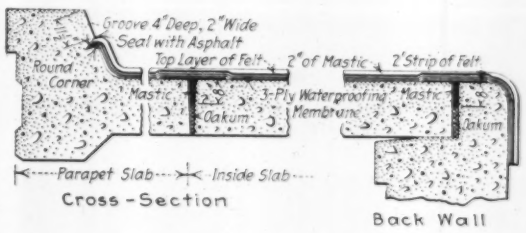


FIG. 4. WATERPROOFING FOR SLAB-DECK BRIDGE

is about 60 ft., supported by the abutments and bents, and its sides are supported on the deck slab and fascia girder. It is 8 ft. 2 in. wide and 6 in. thick, reinforced with longitudinal and transverse rods in the bottom. It contains about 10.3 cu.yd. of concrete and 860 lb. of steel. This slab will be cast in place and will be secured by dowel rods in the tops of the abutments and the fascia girder.

Special attention has been given to the waterproofing of the deck, and the arrangement is shown in Fig. 4. The tapered longitudinal openings between the slabs and the openings between the ends of the deck and the back wall are filled for half their depth with oakum, well hammered down, and then with mastic to the level of the top. Over these joints are laid 24-in. strips of felt or saturated burlap. The concrete surface (clean and dry) is then mopped with an asphaltic priming coat, upon which is laid a membrane of three-ply saturated burlap or felt fabric, each layer being mopped with a waterproofing compound. A second layer of felt or burlap is placed upon this and covered with a 2-in. surface coat of mastic. This forms the finished surface upon which the ballast is laid. At the sides the waterproofing course is carried up the curb wall and is secured in a groove provided for the purpose, being sealed in place with hot asphalt.

This structure, which is a rather new development in railway bridges over country roads, was designed by I. L. Simmons, Bridge Engineer, under the direction of C. A. Morse, Chief Engineer of the Rock Island Lines.

Canadian Water-Power Resources—According to information furnished by officials of the water-power branch of the Canadian Department of the Interior to the Dominion's Resources Commission, Canada has electric power developed to a total extent of 1,712,193 hp. The developed power of the various provinces is as follows: Nova Scotia, 21,412 hp.; New Brunswick, 13,390; Prince Edward Island, 500; Quebec, 520,000; Ontario, 789,466; Manitoba, 56,730; Saskatchewan, 45; Alberta, 33,305; British Columbia, 265,345; Yukon, 12,000. It is estimated that, exclusive of the northern territories, a large part of the Yukon and the northern and eastern portions of Quebec, there is 17,746,000 hp. available for development—8,000,000 hp. of which is in range of present markets and likely to be in use in the course of 15 years.

Panama Canal Annual Report

The annual report just issued by the Governor of the Panama Canal, Gen. George W. Goethals, shows that the total cost of the canal's construction to June 30, 1916, has been $364,118,000. The total appropriations by Congress for the canal, its fortifications, etc., aggregate $415,985,000, but out of this amount over $19,000,000 was for fortifications and over $17,000,000 for the operation and maintenance of the canal since it was opened in 1914. Other appropriations for colliers to bring coal to the canal, etc., make the total of deductions from the total Congressional appropriation sufficient to bring the final construction cost to the amount above stated.

From this total cost of $364,000,000 for construction, however, there should further be deducted material and equipment transferred by the canal to the Alaskan Engineering Commission and the State Department, valued at $7,155,000, and the payments made and to be made by Panama for municipal work done for the cities of Panama and Colon. There is also a considerable amount of other construction material that will eventually be sold. Taking all these into account, it would not be far out of the way probably to say that the total cost to the United States of building the Panama Canal has been $350,000,000.

It is of interest to note here that the engineers' estimate of total cost made in 1908 was $375,201,000. The work has been carried out at unit prices so much below those used in the estimate of 1908 that the sum above noted as the total cost of the canal has included the cost of a number of other important works not included in the estimate of 1908, namely, a 1,000-ft. dry dock, two coaling stations, terminal piers and wharves, hospital buildings at Colon and Ancon, while claims for injuries and deaths of employees amounting to $1,340,000 have been paid, which were not provided for in the 1908 estimate.

It is further of interest to recall in this connection that, according to the figures given in General Goethals' paper at the International Engineering Congress, the cost of construction alone for the Panama Canal was only about $210,000,000, including all expenses up to June 30, 1914. The principal items that swelled the total cost to the $350,000,000 above stated were $17,000,000 for sanitation, $7,000,000 for the government of the Canal Zone, $50,000,000 to the French canal company and the Republic of Panama, $10,000,000 for buildings in the zone, and about $16,000,000 for the Panama railroad and its steamship line.

1,000-Ft. Dry Dock

The new dry dock completed during the year contains 12,897 cu.yd. of mass concrete and 17,757 cu.yd. of reinforced concrete. The average cost of the mass concrete was $5.59 per cu.yd., and of the reinforced concrete $7.73 per cu.yd. The miter sill and quoin posts of the dock are of granite blocks. Great care was used in placing and dressing these blocks to true surfaces, special steel templets being prepared for the purpose. When completed, the maximum variation of the granite sills from a true plane was $\frac{1}{32}$ in. The granite blocks amounted to 425 cu.yd., and the total cost of the completed granite work was $847.87 per cu.yd. The miter gates of the dry dock are of the same design as those used in the canal locks and were built by the same contractors, the McClintic-Marshall Construction Co., of Pittsburgh. The miter posts and the quoin posts of the gates are of greenheart timber from British Guiana. The cost of the gate leaves, exclusive of the greenheart, was $98.92 per ton.

Four pontoons, to be used as small boat landings, were built of reinforced concrete on the floor of the dry dock. These pontoons are each 120 ft. 6 in. long, 28 ft. 2 in. wide and 7 ft. 10 in. deep. They are designed to float with a 3-ft. freeboard. The entire bottom, sides, interior bulkheads and frame up to a height of 6 ft. were cast in one continuous pour. After the forms were stripped, the sides of the pontoons were waterproofed by the Sylvester process. The four pontoons complete with all accessories cost $44,111.

Concrete Blocks for East Breakwater

A breakwater has been built in the bay opposite Colon to protect shipping from the heavy waves created by the trade winds. It is 6,741 ft. in length and is built of rock dumped from a double trestle, the rock in the core being protected from wave action by large blocks of armor rock placed on the slope. This armor rock was quarried at Sosa Hill, on the Pacific side. After excavating from this quarry for some time it was found that the amount of rock it would be necessary to excavate to secure a sufficient amount of large blocks was so large that it was determined to protect the slopes of the breakwater by cast concrete blocks. A contract was let for the manufacture of cubical blocks, 7 ft. on a side, weighing about 50,000 lb., at 38½c. per cu.yd. About 6,700 blocks were delivered under this contract, and in addition the manufacture of blocks was undertaken by hired labor, 7,700 blocks being built in this way of a mixture of run-of-bank gravel and cement 4½ : 1, at a cost of $3.68 to $4 per cu.yd.

Buildings on the Isthmus

The first concrete buildings erected on the Isthmus were of hollow cast concrete blocks. These were cheaper than hollow tile, and it was believed that solid concrete walls would be too damp for the Panama climate. It was found, however, that after the hollow-block wall had received a coat of stucco on the outside and plaster on the inside, it was more expensive than poured reinforced concrete. Buildings are now erected of reinforced concrete for main walls and floors, with blocks for interior partitions only. To save the expense of white plaster, the interior of all concrete buildings is now finished in cement, the surface being treated mechanically and painted in suitable colors.

The use of corrugated iron for roofs of buildings has been standard on the Isthmus from the beginning of canal operations. While satisfactory for temporary buildings, the rapid deterioration and necessary expense for frequent painting, with its unsightly character, make it undesirable for permanent buildings. After experiments with various kinds of roofing material, red asphalt shingles were adopted as the most satisfactory roof covering for frame buildings.

Electric-Power Station and Water-Supply

The hydro-electric power station at Gatun produced current during the year at an average cost of 0.6 mill per kw.-hr., including all operation, maintenance and repair costs and division overhead charges, but not including depreciation. When a 3% charge on the capital cost of the entire power system for depreciation is added, the cost of the power generated at the hydro-electric station was 2.7 mills per kw.-hr. When distributed from substations, including all charges, the cost of the current used for power was 7.7 mills per kw.-hr. The cost for lighting

service, including the maintenance of house-lighting systems and lamp renewals, was 1.45c. per kw.-hr.

The estimated normal yield of the Gatun Lake watershed during the dry season from January to April inclusive is 2,160 sec.-ft. The actual yield in the months of January to April, 1916, was 2,200 sec.-ft. There was discharged during January over the Gatun spillway over two billion cubic feet of water, which would have been sufficient to provide for about 330 lockages in addition to those actually made during the dry season. Experience in the operation of the locks shows that the maximum number of lockages that could be made in 24 hr. is 48, assuming that both chambers are used and that one vessel leaves the upper flight at Gatun just as another enters the lower chamber.

Corrosion of Submerged Metal at the Panama Locks

Although the Panama Canal was completed less than three years ago, the annual report of General Goethals, Governor of the Canal, reveals that parts of the lock machinery have suffered seriously from corrosion, and extensive renewals have already been necessary.

A year ago, in *Engineering News* of Sept. 9, 1915, there was described the destruction of the half-million dollar yacht "Sea Call," within a few months of its completion, as the result of galvanic action between the Monel metal plates of its hull and its steel frames and fittings. Corrosion caused by electrolytic action between dissimilar metals in the valves controlling the lock water supply appears to have been an important factor in the difficulties at Panama.

The paints originally applied to the exterior of the gates also prove to have been short-lived and its replacement with Bitumastic Enamel has been necessary. We quote from General Goethals' report as follows:

At the time the water was let into the locks all the gates had been painted and put in first-class condition. The interiors of the gates were coated with Bitumastic Enamel under a five-year guarantee, and the exteriors covered with various kinds of submarine paints.

When the floating caisson arrived in December, 1914, it was installed at the lower east lock at Miraflores and the chamber pumped out, permitting an examination of the gates, valves, and fixed irons. At that time they were found to be in good condition, although there was some rusting of the plates and rivets. In January, 1915, the west chamber at Miraflores was pumped out after being submerged about 15 months. The paint on the gates was blistering badly, and from experience gained from various paints applied at other lock gates it was decided that something must be adopted that would give better protection than anything in the paint line that had yet been used.

Difficulty had been experienced with paints applied to the spillway gates at Gatun, and because of the condition of the interior of the gates on which Bitumastic Enamel had been used it was decided to test out the use of this material on one of the spillway gates. It appeared to give adequate protection; and as the contractor guaranteed the effectiveness of his material for five years, a contract was entered into for coating all of the lock gates with Bitumastic Enamel. The gates at Gatun were coated and the work finished.

Due to the condition of the pumps in the caisson, the impeller blades of cast iron being entirely eaten away, work on the Pacific side was not completed.

CORROSION OF CYLINDRICAL VALVE PARTS

Observations during the past year disclosed that the corrosive action on the cylindrical valves has been severe. In July, 1915, the west flight of Gatun Locks was drained, and all the accessible cylindrical valves were examined. Marked corrosion was taking place on certain parts of the valves, although the entire valve was made of cast iron or steel, no bronze parts being adopted in the original design. In the lower level an average of 75% of the seal segment nuts were corroded; in some cases fully half the nut had disappeared. It was also found that the bolts holding the stops in place were in such condition that they had to be replaced in every valve in the lower level. All valves were put in good condition and painted with red lead.

On the Pacific locks no examination was made of the valves at Pedro Miguel or those on the west side of the Miraflores center wall, but the east valves at this site were found to be in good condition; however, as all painted surfaces of the valves had failed, it was decided to coat all exposed iron and steel surfaces with Enamel, and a contract was entered into for doing this work.

CORROSION IN THE RISING-STEM VALVES

Considerable corrosion has taken place in the rising-stem valves. The half-inch plates have been attacked in a manner similar to those on the lock gates, and portions in the vicinity of the rivets in the lower valves at Gatun and the upper and lower valves at Miraflores have been violently attacked. The bottom seal casting of the valve which comes in contact with the babbitt-metal seal on the bottom of the valve is being rapidly eaten away. A number of the valves at the Pacific locks were in such condition that the bottom seal had to be machined off to make the valve tight.

In order to protect the valve from any further electrolytic action between the cast-steel seal and the lower babbitt-metal seal, all babbitt-metal was removed and replaced with a seal of greenheart lumber. Some of the bronze side-seals and springs were found to be broken both at Miraflores and Gatun. Otherwise the seals were in good condition and required only a small amount of draw-filing to make the contact surfaces perfect. The top gate-valve seal is of cast steel and is held in place by bronze bolts. In practically every instance the corrosion has been excessive around the heads of the bronze bolts, cutting away the metal and in some cases allowing the bolts to loosen and fall out. Several castings had to be replaced. The worst case of corrosion of the seal occurred on the upper valves at Miraflores.

At Gatun practically all valves were installed with fixed side-seal castings, which all gave evidence of considerable corrosion, but not sufficient to cause any leaks. At Miraflores removable side-seal strips were of machinery steel, and in every case corrosion had reached such a point that all side-seals had to be replaced. Inasmuch as the corrosion had apparently been aided by the proximity of the bronze side-seals which bear upon them, it was decided to replace all machinery steel with lignum-vitæ wood, in this way tending to place an insulating substance in contact with the bronze. All porous concrete around the fixed irons was removed and replaced with cement, and wherever babbitt-metal had been used to fill the recessed holes for bolt-heads at the Pacific locks the metal was removed and replaced with cement.

CORROSION OF ROLLER TRAINS

At both the Atlantic and Pacific locks considerable corrosion of roller trains has occurred, the rollers of which are made of tool steel. At the Atlantic locks a number of rollers, bolts, and filler castings were missing. All were replaced, and the heads of all bolts were riveted over to prevent further losses. Similar conditions were found at the Pacific locks, and as it is impossible to protect the rollers by any paint, arrangements were made to install one-half inch pipes from the tunnel floors down to the base of the roller-train tracks. Crude oil is forced through the pipes, and it is believed from the results of experiments made with a model that the crude oil will rise along the surface of the roller-train track and in this way protect the rollers by coating them with oil.

As a result of the examination of the valves at Gatun it was decided to have them coated with Bitumastic Enamel. At the Pacific locks more complete protective measures were taken, as follows: (1) All bronze side-seals were lined up and strips of zinc bolted to the valve each side of the seals at the bottom of the valve; (2) where necessary, the bottom-valve seal was machined off to give solid metal contact with the bottom seal; (3) all removable side-seal strips were taken out and replaced with lignum-vitæ wood strips. Where removable strips were not installed, the fixed irons were milled down to take the wooden side-seals; (4) all babbitt metal used in the assembly of the valve for embedding and protecting bolt heads from corrosion and for calking purposes was removed and replaced with cement; (5) all babbitt-metal used in the bottom seal was removed and replaced with greenheart lumber; (6) all steel work of the valve was coated with Bitumastic Enamel. This left only the bronze side-seals exposed; (7) all fixed irons were coated with Bitumastic Enamel; (8) the channel-iron supports for the rollers were coated with Bitumastic Enamel and arrangements made to lubricate the roller trains and tracks with crude oil during operation and while the valves are submerged; (9) all submerged portions of the valve stems were coated with Bitumastic Enamel; (10) all bronze bolts are being replaced with steel as fast as breakage occurs.

Horse or Motor for Collecting City Garbage

By B. F. Miller, Jr.*

In this age of the motor, when almost every day develops some new use for its power, one might quite naturally imagine that in the collection of municipal garbage and refuse the sooner the horse-drawn vehicles were discarded the better. An investigation of this subject in 125 American cities discloses the fact that there is still much to be said in favor of the horse, especially for garbage collection.

The writer here submits the arguments pro and con, received in response to a circular letter sent to 225 American cities, from which about 125 replies were received. It will be noticed that comparatively few cost data are given, due primarily to the fact that so few cities have used motor apparatus (105 are still using horse-drawn apparatus), or that some of them have not used it long enough to have compiled any data of value. The replies showed:

1. A growing tendency toward placing garbage collection under the active supervision of departments of public works, as opposed to supervision by health boards.

2. A decided sentiment in favor of municipal collection instead of the prevailing contract system.

3. An awakened interest in the serious study of garbage collection and disposal, as for example, the excellent report of I. S. Osborn on the collection and disposal of garbage for the District of Columbia.

Briefly summarized from the replies, the principal arguments for the use of motor-driven vehicles for garbage collection are as follows:

1. Where the garbage can be delivered to a central unloading station and then taken from this point to the disposal plant with motor vehicles, there is no doubt much economy in the use of the motor. However, the practicability of a central station is somewhat doubtful. It would, to be of advantage, have to be located in a somewhat populous district, and several cities, notably Seattle, that have tried this plan have discarded it because of the serious objections of people living in the neighborhood of the central station. If some means of eliminating the objectionable odors at the central station were devised, possibly it might become practicable. Of course, with such a station the hauls of the horse-drawn wagons would be shortened, and much time would be saved in not having the collectors make the trip to the disposal plant.

2. Los Angeles reports that motors in residence districts are advantageous over teams because collections can be made more regularly and that motor collection is at least as cheap as horse collection under similar conditions.

Los Angeles is using two 2½-ton trucks for garbage collection in its residence district. The first collection is 8 mi. from the reduction plant. The cost of collection and delivery to the plant by motor is $2.75 to $3 per ton; by team it is $2.37. The trucks are operated by one driver and two collectors and make two loads per day. Each truck travels from 20 to 40 mi. per load collected and works 8 hr. per day. In the same district a team of three horses and driver made one load per day, wagons hauling 2½ to 3 tons per load and trucks 2½ to 3½ tons. The cost given above includes maintenance, depreciation and interest. The cost data for horses included depreciation for stock, but no account was taken of extraordinary wear on stock due to long hauls.

3. Pasadena reports using a 7-yd. truck, costing $2,450, for refuse collection. The life of the truck is 5 yr., and the cost of operation is $7.11 per day, exclusive of depreciation, but including oil and distillate. This truck averages 42 mi. per day, hauling 16 cu.yd. average, and replaces two two-horse and two one-horse wagons. The two two-horse wagons covered 20 mi. per day and the two one-horse wagons covered the same distance. The truck requires two men to operate, while the wagons require four men and six horses.

4. Spokane reports that, for residence districts, long hauls and heavy loads, one truck takes the place of four teams.

5. Tampa reports a 50% saving in the use of the motor truck, in replacing horse-drawn apparatus, for partial collection only. In street-cleaning apparatus a 50% saving was effected. No figures were given to prove this statement.

6. Detroit uses motor collection from hotels and restaurants and also from central collection station.

7. Joliet, Ill., uses motor trucks from central station.

8. Brockton (Mass.), Montgomery (Ala.), Paterson (N. J.), and Augusta (Ga.), have discarded horse-drawn apparatus and installed motors for house-to-house collection, but are not yet ready to report cost data.

9. The Norfolk Navy Yard expects one motor truck to replace one two-horse and three one-horse teams.

10. Buffalo is considering central collection depots and motor delivery from this point to the disposal plant.

11. Nashua, N. H., collects rubbish with a truck and finds that one truck does the work of from two to three teams and shows much economy.

The objections to motor apparatus, as given, were briefly as follows:

1. The speed gained on the long hauls is more than offset by the time consumed in getting on and off the truck while loading.

2. With a truck, a driver would be necessary all the time in addition to the other operators, thus adding extra cost, while with horses, a team or single horse can be trained to move from house to house at a call from the driver, who also collects the cans.

3. Either the life of the motor will be shortened, owing to many stops and starts, or if the engine is allowed to run, excessive use of gasoline results.

4. Many cities place refuse in sanitary fills, and motors are not practical in low marshy ground.

5. The cost of motor equipment is considered by many to be prohibitive.

6. The Denver Hog Ranch Co., which collects garbage for the City of Denver, says:

We are using teams to collect garbage from the City of Denver, in preference to trucks, our haul being about 5 mi. The rainfall in this country is only about 13 to 15 in. per annum; consequently, the roads are usually in good condition, except perhaps for a short time in the spring. We have gone over the truck proposition several times with different salesmen who had an idea that they could save us money on the collection and removal of the garbage, but it is our conclusion after careful investigation that the only way a saving might be made would be to have all the garbage collected and removed to a central point and then hauled from this central point to a place of disposal.

7. Motor vehicles are not adapted to pick-up work.

8. In northern climates, where heavy snows are prevalent, motor trucks are not suitable even for long hauls.

*City Engineer, Meadville, Penn.

9. Syracuse, N. Y., is discarding trucks for house-to-house collection and using them for hauling from a central station.

10. Toledo has discarded trucks, on account of heavy grades and rough roads.

11. Dayton experimented with one truck in house-to-house collection and found that it did not pay. The cost to collect with truck was $1.37 per ton, as against $1.09 for horse collection.

From the foregoing replies the following conclusions may be drawn:

1. Motor vehicles are not practicable for house-to-house collection of garbage, except perhaps in a few instances where residences are far apart, as in Los Angeles and Pasadena.

2. Where it is possible to establish central stations (and there does not seem to be an immediate possibility that they will become very popular), the motor will prove an economy for the long haul.

3. In refuse collection the motor seems to show considerable economy.

4. In downtown districts it would appear that better service, even though not as cheap, might be obtained from trucks in collections from hotels and restaurants.

5. Horse-drawn apparatus seems most suitable for house-to-house collection and for delivery to central loading stations, for the reasons given above.

Motor-Truck-Highway Problem

The legislature of the State of New York recently passed an act to amend the highway law in relation to registration fees for motor trucks and omnibuses. The act requires that a commission comprising the state commissioner of highways, the superintendent of public works and the state engineer shall adopt and file in the office of the secretary of state on or before Jan. 1, 1917, a new schedule of registration fees to be paid by the owners of motor omnibuses and motor trucks. These fees are to be based "upon the time and extent of the vehicles' use of the public highways, and the relative wear and tear of the highways resulting from their use."

On Nov. 21, the first public hearing of this special commission was held in the capitol at Albany, Edwin A. Duffey, state highway commissioner, acting as chairman. Between 40 and 50 persons attended the hearing, the great majority of them being representatives of motor-vehicle manufacturers and owners. In fact but a single representative was present to state the case of the highway official and the general public, and that man was Eugene W. Stern, chief engineer of the Bureau of Highways, Borough of Manhattan, New York City, whose experience in maintaining pavements under extraordinarily heavy motor-truck traffic has been described in *Engineering News*, Oct. 12 and Nov. 16, 1916.

The substance of the contentions made by the motor-truck interests were: (1) That the commission's jurisdiction could not be interpreted to include any but state highways; (2) that a large number of motor vehicles in cities never use the state highways; (3) that there were too many variables entering into the problem to ever reach a fair determination of the wear of highways caused by motor trucks; (4) that the task before the commission was an impossible one, because anything in the nature of special fees was discriminatory and unconstitutional; (5) that it was the business of the government to build the roads adequate to traffic; (6) to maintain the roads by general taxation and (7) that they had an inalienable right to use the public highways for any purpose they saw fit.

Mr. Stern contended, that stripped of the clouds which were thrown around it, the problem was only one of common sense—the police power to protect public property. He would absolutely prohibit the use of vehicles which were proved destructive to the public highways. His illustrations were drawn from the destruction of the pavements on West 42nd St., and on other streets in New York City by the 18-ton subway contractor's motor trucks.

The motor truck representatives readily admitted the damage in this case but claimed that this was an exceptional and unique instance; also it was hinted that the pavements were not the best. Mr. Stern stated that damage done by these few trucks in less than a year amounted to $9,000 per mi. of pavement—and the best types of city pavement at that. He said New York City officials were at work on an ordinance to prevent recurrence of this destruction.

Some constructive suggestions were made by representatives of the motor truck manufacturers, one being that the fees should be based on Gross Weight × Speed × A Factor. The difficulty of controlling the speed of motor vehicles was, however, emphasized, one automobile engineer stating that there was no gasoline-engine governor which was not easily tampered with.

The various elements which it was suggested must enter into any formula that would meet the specification for the fees required by the law were: Kind of tires, springs, type of pavement, season of year, gross load, load per inch of tire and diameter of wheel.

The Motor Truck Club of America was represented at the hearing by its president Roderick Stephens, George H. Pride, W. O. Shadbolt, G. A. Green, A. F. Masury and Arthur J. Slade, as well as its counsel, Charles G. Bond.

It was tentatively agreed to hold another hearing in New York City.

Railway Clearances in Switzerland were modified by a new federal order of Mar. 18, 1916, to conform to new maximum car and lading outlines adopted by an international conference early in 1914. The new clearance diagram is coupled with a maximum car and lading outline, and a limiting line for existing structures and for repair or maintenance operations. This last is intermediate between the car and clearance lines. The main widths are: Car, 3.15 m.; existing structures, 3.55 m. on main track and sidings, 3.35 m. on loading tracks; clearance, 4 m. (13.12 ft.). The heights above top of rail and the top widths are: Car, 4.50 m.; height, 1 m. top width; existing structures, 4.55 m. height, 1 m. top width; clearance, 4.80 m. height, 1.52 m. top width. The upper corners are formed not by a single slant, but by two lines forming a very flat obtuse angle. The principal offset of the side clearance line is 0.76 m. above top of rail, to a width of 3.30 m.; for existing structures the height of offset is 0.90 m., to a width of 3.25 m. The bottom widths are: Car, 2.40 m. at 0.13 m. above top of rail; clearance, 2.43 m. at 0.05 m. above top of rail. Variations of ¾ to 3 in. in lateral position of railway vehicles in most unfavorable position on curve are allowable at certain specified heights; this presumably relates to spring action, as a table of increase of clearance width on curve is also specified. The full text of the new regulation is given in "Schweizerische Bauzeitung" of June 3, 1916. It is noted that the clearance diagram differs from that of 1894 chiefly in greater width at the lower corner, where the new diagram slants from bottom width 2.43 m. at 0.05 m. above rail to width 3.09 m. at 0.38 m. above rail.

News of the Engineering World

Rock Tunnel 18 Miles Long for New York Water-Supply

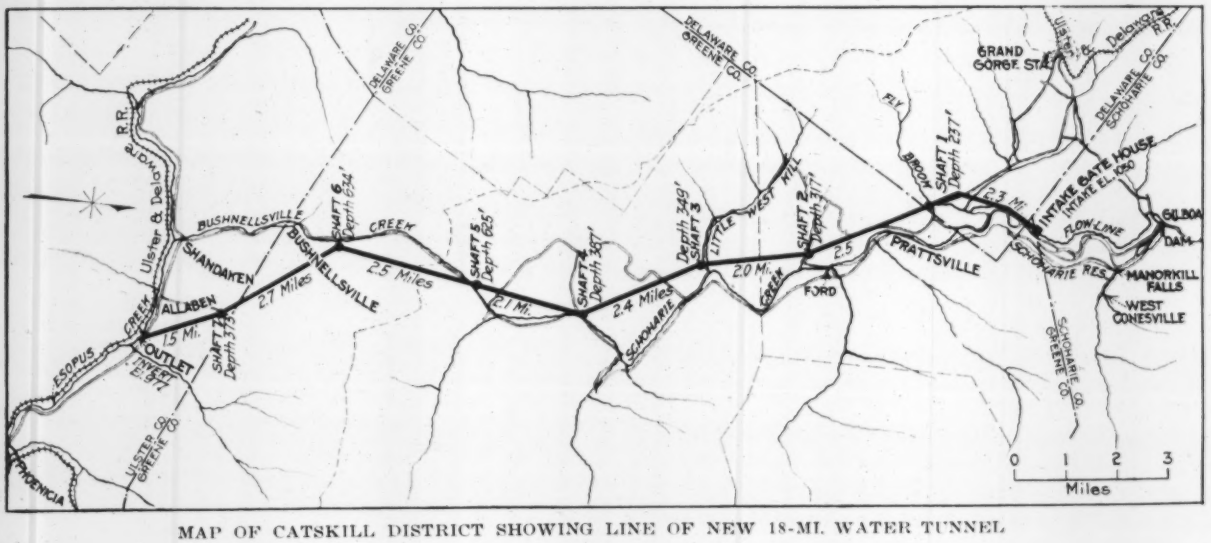
The Board of Water Supply of the City of New York has given notice that a contract will be let next spring for an 18-mi. tunnel through one of the main ranges of the Catskill mountains, to divert the waters of Schoharie creek into the Ashokan reservoir. This tunnel is one of the principal features in the development of the other half of the 500,000,000-gal. daily supply from the Catskill watersheds, for which appropriation was made in April (see *Engineering News*, Mar. 2, 1916, p. 435).

The water from the Schoharie drainage area (314 sq.mi.) will be impounded by a large dam (probably between 200 and 300 ft. high) with an outlet through this 18-mi. concrete-lined tunnel, which is to be about 11 ft. in diameter, into the Ashokan reservoir. The now practically completed aqueduct from the Ashokan reservoir to New York City has a capacity of 500,000,000 gal. daily. The estimated cost of utilizing the Schoharie watershed is $22,000,000 and the construction of the dam and tunnel will probably require 8 yr.

The projected tunnel, as shown by the accompanying plan, extends from a point on Schoharie creek between the towns of Prattsville, Greene County, and Gilboa, Schoharie County, to a point on Esopus creek in the town of Shandaken, Ulster County. The tunnel will be driven from 8 shafts, ranging in depth from 240 to 640 ft., except the shaft at the northerly end, which will be only 100 ft. deep. The distances between shafts vary from 10,400 to 14,200 ft. The rock is blue and red sandstone (commonly called bluestone) and embedded shales characteristic of large portions of the Catskill mountain regions. Diamond-drill borings are now in progress to furnish data for final location.

The tunnel will be at hydraulic gradient and not a pressure tunnel, except the section between the inlet gate-house and shaft No. 1, which will be depressed to pass beneath the gorge of Bear Kill and other possible depressions in the rock. The slope of the tunnel proper will be about 4 ft. per mi. The minimum thickness of the concrete lining will be 12 in.

J. Waldo Smith is Chief Engineer, and Alfred D. Flinn is Deputy Chief Engineer of the Board of Water-Supply.



MAP OF CATSKILL DISTRICT SHOWING LINE OF NEW 18-MI. WATER TUNNEL

Wilmington Water-Works Changes

The four-states section of the American Water-Works Association met in Wilmington, Del., Nov. 15, for a most interesting and instructive session. The forenoon was devoted to an inspection of the pumping plant, the site of the new mechanical filtration plant, a large covered concrete reservoir now under construction, and a slow sand filtration plant that has been in continuous operation since 1909.

Within the last two years the sudden increase in water consumption, due chiefly to new manufacturing demands, has set at naught all previous calculations, and has required radical developments and improvements to be undertaken. These developments, and the part the Wilmington water-works has played in water-purification history, furnished the theme for the afternoon discussion, which was led by George W. Fuller, New York City, consulting engineer for the city.

The development of an additional water-supply involves the construction of a 12,000,000-gal. rapid sand filter plant adjoining the present pumping station. The present preliminary filters are being changed into a coagulating basin and storehouse. Beneath the new filters will be a filtered-water reservoir of 360,000,000 gal. capacity. The pumping plant, with the present two Holly high-duty pumping engines (each 12,000,000 gal. daily capacity)

will be increased by three new steam-turbine-driven centrifugal pumps of a total capacity of 30,000,000 gal. daily.

The water from the new rapid sand filter plant will be pumped to two distributing reservoirs, one a new 7,500-000-gal. covered concrete reservoir of a beam and girder type roof. This roof will be used as a park, playground and skating rink.

The present slow sand filtration plant at Weldin Farm, about 2 mi. from the pumping station, will continue in use, the intention being to operate the mechanical filters when the water is particularly turbid, and the slow sand filters at other times, although both may be used simultaneously.

At present the water is taken from Brandywine Creek, conducted in an open channel to the pumping station, where it is passed through preliminary filters and pumped to the Porter reservoir at Weldin Farm. From here the water passes through the slow sand filters to a reservoir beneath, and thence into the city mains.

The chief engineer of the Wilmington water-works is Edgar M. Hoopes, Jr., and S. N. Van Trump is superintendent.

California Votes $15,000,000 for More Road Work

The vote on issuing bonds to the amount of $15,000,000 to complete the California State Highway Department program was overwhelmingly in favor of the issue, according to press dispatches. This money will not be available until July 1, 1917, and in the meantime the State Highway Department is threatened with a serious shortage of funds.

The proposed state highway system comprises 3,300 mi., of which 1,400 has already been completed, or is near completion, under the original $18,000,000 bond issue. The new bonds will bear interest at 4½%.

It has also been announced that California is the first state to receive Federal aid under the new road law.

Cleveland To Mend Pavements

A bond issue of $3,000,000 for repairing and repaving the streets of Cleveland, Ohio, was carried at the recent election. The agitation for this work was begun several years ago, and the condition of the pavements became the subject of investigation by civic associations. Recently much promotion and publicity work was done by a Committee of One Hundred Organizations. A tentative program has already been adopted for the 1917 work, which will take care of at least 10 mi. of the most urgent repairs and repaving, according to press reports.

The Mining Congress and the Holmes Memorial

The 19th annual session of the American Mining Congress, held at the La Salle Hotel, Chicago, Nov. 13 to 16, dealt mainly with legislation and with the general administration and commercial aspects of mining, rather than with technical matters. Some of the subjects were related more or less directly to engineering and practical mining, the latter including safety work and rescue methods. Among the papers listed were "Uniform Mining Legislation as Affecting Mining Engineering," by J. A. Garcia, of Chicago, and "The Engineer's Relation to Western Water-Power Development," by Dr. Henry S. Drinker (Lehigh University), of South Bethlehem, Penn.

In addition to five general sessions there were 14 sectional meetings of the five divisions on legislation, coal, metalliferous, public lands, and oil and gas. At one of the general sessions a strong appeal was made for subscriptions to the Joseph A. Holmes Safety Association, which has been organized as a permanent memorial to the late Dr. Holmes (head of the U. S. Bureau of Mines), and with the purpose of developing safety in mining operations. This is a unique method of commemorating in a permanent and useful way Dr. Holmes' valuable and energetic work in the interests of the mining industry.

A Million Dollar Fund for the United Engineering Library

The consolidation of the library owned by the American Society of Civil Engineers with the United Engineering Library, owned by the three other great national societies —the Mining, Mechanical, and Electrical Engineers— makes this the greatest collection of engineering books in the world. The trustees of the United Engineering Society, which controls the administration of this library, are seeking to raise a million-dollar endowment, the income of which will be available for the perpetual administration and enlargement of the library. On Nov. 15, the president of the United Engineering Society, Charles F. Rand, announced the gift by Dr. James Douglas, of New York City, of $100,000 toward this endowment fund. Dr. Douglas is a past-president of the American Institute of Mining Engineers and is president of the Phelps-Dodge Co., of New York City.

Taxation Changes Proposed for Pittsburgh

Among 20 recommendations made by a taxation committee in a report submitted Nov. 13 to J. G. Armstrong, mayor of Pittsburgh, Penn., six are here reprinted as of interest to many engineers:

Immediate adoption of a comprehensive city plan, including the "zoning" principle, in order that existing realty values may be conserved.

Adoption of principle of excess condemnation in making public improvements, especially in laying out of new streets and in widening or extending old ones.

The water department, as a social or community enterprise, should make no profit, but should be self-sustaining.

Larger revenues should be obtained from the rental and use of city property—wharves, markets, etc.

Increase of the automobile license tax by 50 per cent., and distribution of the total proceeds, 30 per cent. to the city, 30 per cent. to the county, 40 per cent. to the state.

Abolition of the exemption of machinery in the city.

The committee was composed of 14 members, including William Price, chairman, and Julian Kennedy.

Will Jacket Clearwater Basin with Reinforced Concrete

Bids are being asked on a $200,000 reinforced-concrete job of unusual character. The clearwater basin of Cleveland's new filtration plant, a covered groined-arch structure 195x938 ft. in plan by 30 ft. high, is to be repaired or reconstructed, in consequence of the partial failure that occurred July 10, 1916, as described in *Engineering News* of July 27, 1916, p. 186. After that failure, which consisted of the fall of four panels of roof and their

supporting columns, further evidences of damage appeared. Engineers engaged to report on the case recommended finally a complete jacketing of the old structure, the process being virtually a replacement of the present basin structure, leaving the old work in place and using it as form for the new work.

There will be a new floor slab, laid on top of the present floor; a new roof slab, laid on top of the present roof; new side walls, carried up inside the existing walls and communicating with the new roof by way of openings at the top of the existing walls; and hooped jacketing for the columns. All of the new concrete is to be fully reinforced.

G. B. Dusinberre, Commissioner of Water, City Hall, Cleveland, is in charge of the reconstruction.

Montreal's Municipal Water-Power Project Condemned

A commission of prominent engineers made a report on Nov. 20 to the city authorities of Montreal on the water-power project which has been under construction for several years in connection with the city's water-supply. The commission finds that the final cost of the project will be at least $10,600,000, and that not over 7,000 hp. will be developed. The minimum fixed charges and operating expenses of the power plant will be $108 per hp. per annum while the city could purchase power in the open market from some of the hydroelectric plants in the vicinity of Montreal for not more than $20 to $25 per hp. per annum.

The commission urges that the city should abandon the present project, on which it has already expended over five million dollars, and estimates that by so doing it can save $262,000 per annum by purchasing power compared with the cost of completing the present project.

Navy Department Wants Four Designing Engineers

The Bureau of Yards and Docks, Navy Department, at Washington, is in immediate need of four high-grade designing engineers at salaries of from $10 to $15 per day, and the Civil Service Commission is announcing an early non-assembled competitive examination from which to provide eligibles. The announcement of the examination (issued Nov. 20, 1916) is in part as follows:

The United States Civil Service Commission announces an open competitive examination for designing engineers, for men only, to fill four vacancies at salaries ranging from $10 to $15 per diem in the Bureau of Yards and Docks, Navy Department, Washington, D. C. The duties of the position embrace the design and supervision of design of large and various engineering works in steel, concrete, reinforced concrete, etc., for the navy yards and naval stations.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

Subjects	Weights
1. Technical education	30
2. Experience and fitness	70
Total	100

Graduation with a degree in engineering from a college or university of recognized standing, with subsequent experience of not less than 15 years on general design work, of which not less than five years must have been in responsible charge in the successful designing of works of importance and magnitude, such as structural steel shops and storehouses, reinforced-concrete structures, retaining walls and deep foundations, tunnels or subways, waterfront work, such as quay walls, piers, wharves or dry docks, etc., are prerequisites for consideration for this position.

In view of the early date of examination demanded by the urgency of making appointments as soon as possible, it is necessary that persons desiring to be considered should secure the necessary form at once and mail it, properly executed, to the Commission without delay.

Applicants must not have reached their fifty-fifth birthday on the date of the examination.

Persons who meet the requirements and desire this examination should at once apply for Form 1312, stating the title of the examination desired, to the United States Civil Service Commission, Washington, D. C.; the Secretary of the United States Civil Service Board, Post Office, Boston, Mass., Philadelphia, Penn., Atlanta, Ga., Cincinnati, Ohio, Chicago, Ill., St. Paul, Minn., Seattle, Wash., San Francisco, Calif., Customhouse, New York, N. Y., New Orleans, La.; Old Customhouse, St. Louis, Mo. Applications should be properly executed, excluding the medical certificate, and must be filed with the Commission at Washington prior to the hour of closing business on Dec. 11, 1916.

ENGINEERING SCHOOLS

University of Pennsylvania

The Board of Deans of the University recently adopted a resolution requesting all members of the faculty to give information before undertaking any work outside of the University which would be in conflict with a University statute, which says:

No officer of instruction shall engage in any other occupation which, in the opinion of the trustees, will interfere with or impair the satisfactory discharge of his duties in the University.

Western Reserve University

The Division of Municipal Administration and Public Service of the new School of Applied Social Sciences is offering a general course in municipal organization for municipal and county employees. The course will be under the direction of A. R. Hatton, and much of the work will be given by H. G. Hodges, formerly in the Philadelphia Department of Public Works. It is aimed to break away from the more familiar courses in municipal government.

NOTES

A Preliminary Outline of a City Plan for Cincinnati, Ohio, is to be submitted by George E. Kessler, St. Louis, Mo., to the City Planning Commission of Cincinnati in December. The outline will be based largely on a survey of past, present and prospective improvements made by the engineering and park departments.

Direct Rapid Transit from the South Station, Boston, to Harvard Square, Cambridge, Mass., will be afforded in a few weeks by the equipment and operation of the portion of the Dorchester Tunnel in Summer St., between the South Station and Washington St. This will be done by the Boston Elevated Railway Co.

The Consumption of Cotton Fiber in the manufacture of explosives has reached enormous proportions. During the year 1915 there were used in making explosives in the United States 244,000 bales of bleached cotton fiber (of 500 lb. each), and during the first nine months of 1916 there were 421,695 bales so used. Besides this consumption in the United States the heavy consumption of export cotton for the same purpose is well known. It is apparent that a large percentage of the cotton crop is now being converted to explosives, which furnishes one explanation why cotton is selling at 20 to 21c. per lb., the highest price reached since the Civil War.

Steel Rail Prices Raised to $38 Per Ton—The steel rail manufacturing companies announced last week a further in-

crease in the price of standard steel rails to $38 per ton at the mill. The regular capacity of most of the steel rail mills, however, is reported to be covered by contracts for material already sold, of course at previous market prices, so that the new selling price of steel rails will chiefly affect rails to be delivered nearly a year hence. Even at this advance in price, however, it is noteworthy that steel rails, which, up to a short time ago were the aristocrat of the steel market, selling at a higher price per pound than other rolled material such as structural shapes, are now selling at a lower rate than any other rolled material. Under these conditions there will be little dispute that the manufacturers were justified in making the advance in price.

The New Coaling Plant of the Panama Canal at Cristobal is announced by the "Canal Record" to be now in regular operation for commercial use, although not yet entirely completed. Two of the four reloader towers have been taken over for operation and are found to be able to deliver coal to vessels usually faster than it can be handled. A ship recently coaled had a large open hatch amidship over self-trimming bunkers, and 1,250 tons were delivered to this vessel in 3 hr. These reloaders were designed for rapid delivery of coal to barges and colliers, with large and conveniently placed hatches. As merchant vessels, however, have a great variety of hatches and coaling ports, it is probable that portable pipe chutes will be added to the reloaders. These chutes will be so arranged that they can be swung to various positions, so as to deliver the coal to ports inaccessible to the ordinary reloader chute.

Preparedness in Military Troop Transportation is dealt with in the report of a special committee of the American Railway Association, appointed to coöperate with the United States military authorities in moving troops to the border. From June 29 to Nov. 11 there were sent to the Mexican border approximately 136,000 soldiers; 33,000 have been returned, 9,000 are in mobilization camps and still to be sent to the border, and 103,000 who are down there must be returned. The committee says: "The routing of troops from mobilization camps to border points was specified by the Quartermaster General's department. The routes were apparently arranged to give as many railways as possible an opportunity to participate in the traffic. While in most cases the routing was excellent, there were still cases where troops were handled over circuitous routes with resulting dissatisfaction." The committee recommends that a statement be obtained from the War Department of possible concentration points to which troops might be sent on the several coasts and on the Mexican border, and that a series of possible and preferred routings be prepared from the several mobilization camps to such concentration points. It also proposes that arrangements for pooling the expenses and earnings in the movement of troops be made so that direct routes may be in all cases selected. One feature that enabled the movement of troops to be made promptly was the exchange of passenger equipment on a large scale, something entirely new in the history of American railroading in any such proportions.

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supporting columns, further evidences of damage appeared. Engineers engaged to report on the case recommended finally a complete jacketing of the old structure, the process being virtually a replacement of the present basin structure, leaving the old work in place and using it as form for the new work.

There will be a new floor slab, laid on top of the present floor; a new roof slab, laid on top of the present roof; new side walls, carried up inside the existing walls and communicating with the new roof by way of openings at the top of the existing walls; and hooped jacketing for the columns. All of the new concrete is to be fully reinforced.

G. B. Dusinberre, Commissioner of Water, City Hall, Cleveland, is in charge of the reconstruction.

Montreal's Municipal Water-Power Project Condemned

A commission of prominent engineers made a report on Nov. 20 to the city authorities of Montreal on the water-power project which has been under construction for several years in connection with the city's water-supply. The commission finds that the final cost of the project will be at least $10,600,000, and that not over 7,000 hp. will be developed. The minimum fixed charges and operating expenses of the power plant will be $108 per hp. per annum while the city could purchase power in the open market from some of the hydroelectric plants in the vicinity of Montreal for not more than $20 to $25 per hp. per annum.

The commission urges that the city should abandon the present project, on which it has already expended over five million dollars, and estimates that by so doing it can save $262,000 per annum by purchasing power compared with the cost of completing the present project.

Navy Department Wants Four Designing Engineers

The Bureau of Yards and Docks, Navy Department, at Washington, is in immediate need of four high-grade designing engineers at salaries of from $10 to $15 per day, and the Civil Service Commission is announcing an early non-assembled competitive examination from which to provide eligibles. The announcement of the examination (issued Nov. 20, 1916) is in part as follows:

The United States Civil Service Commission announces an open competitive examination for designing engineers, for men only, to fill four vacancies at salaries ranging from $10 to $15 per diem in the Bureau of Yards and Docks, Navy Department, Washington, D. C. The duties of the position embrace the design and supervision of design of large and various engineering works in steel, concrete, reinforced concrete, etc., for the navy yards and naval stations.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

Subjects	Weights
1. Technical education	30
2. Experience and fitness	70
Total	100

Graduation with a degree in engineering from a college or university of recognized standing, with subsequent experience of not less than 15 years on general design work, of which not less than five years must have been in responsible charge in the successful designing of works of importance and magnitude, such as structural steel shops and storehouses, reinforced-concrete structures, retaining walls and deep foundations, tunnels or subways, waterfront work, such as quay walls, piers, wharves or dry docks, etc., are prerequisites for consideration for this position.

In view of the early date of examination demanded by the urgency of making appointments as soon as possible, it is necessary that persons desiring to be considered should secure the necessary form at once and mail it, properly executed, to the Commission without delay.

Applicants must not have reached their fifty-fifth birthday on the date of the examination.

Persons who meet the requirements and desire this examination should at once apply for Form 1312, stating the title of the examination desired, to the United States Civil Service Commission, Washington, D. C.; the Secretary of the United States Civil Service Board, Post Office, Boston, Mass., Philadelphia, Penn., Atlanta, Ga., Cincinnati, Ohio, Chicago, Ill., St. Paul, Minn., Seattle, Wash., San Francisco, Calif.; Customhouse, New York, N. Y., New Orleans, La.; Old Customhouse, St. Louis, Mo. Applications should be properly executed, excluding the medical certificate, and must be filed with the Commission at Washington prior to the hour of closing business on Dec. 11, 1916.

ENGINEERING SCHOOLS

University of Pennsylvania

The Board of Deans of the University recently adopted a resolution requesting all members of the faculty to give information before undertaking any work outside of the University which would be in conflict with a University statute, which says:

No officer of instruction shall engage in any other occupation which, in the opinion of the trustees, will interfere with or impair the satisfactory discharge of his duties in the University.

Western Reserve University

The Division of Municipal Administration and Public Service of the new School of Applied Social Sciences is offering a general course in municipal organization for municipal and county employees. The course will be under the direction of A. R. Hatton, and much of the work will be given by H. G. Hodges, formerly in the Philadelphia Department of Public Works. It is aimed to break away from the more familiar courses in municipal government.

NOTES

A Preliminary Outline of a City Plan for Cincinnati, Ohio, is to be submitted by George E. Kessler, St. Louis, Mo., to the City Planning Commission of Cincinnati in December. The outline will be based largely on a survey of past, present and prospective improvements made by the engineering and park departments.

Direct Rapid Transit from the South Station, Boston, to Harvard Square, Cambridge, Mass., will be afforded in a few weeks by the equipment and operation of the portion of the Dorchester Tunnel in Summer St., between the South Station and Washington St. This will be done by the Boston Elevated Railway Co.

The Consumption of Cotton Fiber in the manufacture of explosives has reached enormous proportions. During the year 1915 there were used in making explosives in the United States 244,000 bales of bleached cotton fiber (of 500 lb. each), and during the first nine months of 1916 there were 421,695 bales so used. Besides this consumption in the United States the heavy consumption of export cotton for the same purpose is well known. It is apparent that a large percentage of the cotton crop is now being converted to explosives, which furnishes one explanation why cotton is selling at 20 to 21c. per lb., the highest price reached since the Civil War.

Steel Rail Prices Raised to $38 Per Ton—The steel rail manufacturing companies announced last week a further in-

crease in the price of standard steel rails to $38 per ton at the mill. The regular capacity of most of the steel rail mills, however, is reported to be covered by contracts for material already sold, of course at previous market prices, so that the new selling price of steel rails will chiefly affect rails to be delivered nearly a year hence. Even at this advance in price, however, it is noteworthy that steel rails, which, up to a short time ago were the aristocrat of the steel market, selling at a higher price per pound than other rolled material such as structural shapes, are now selling at a lower rate than any other rolled material. Under these conditions there will be little dispute that the manufacturers were justified in making the advance in price.

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of Aldermen from 1899 to 1903, as Superintendent of the Water Department from 1905 to 1907, and as member of the Board of Street Commissioners from 1913 to 1916. He was appointed City Engineer in 1914. Mr. Sinclair was also Consulting Engineer of the Public Service Commission of Vermont. He was chairman of the Vermont section of associate members of the United States Navy consulting board; he was a past-president of the Vermont Society of Civil Engineers. He is survived by a widow and three children.

ENGINEERING SOCIETIES

PAVING BRICK INSTITUTE.
Dec. 5-6. Meeting in Cleveland at Statler. Asst. Secy., H. M. Macdonald, 830 Brotherhood of Loc. Engrs. Bldg., Cleveland, Ohio.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

NORTHWESTERN ROAD CONGRESS.
Dec. 8-9. In Chicago. Secy., J. L. Long, Moline, Ill.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 27-28. Annual meeting in Tulsa. Secy., H. G. Hinckley, Oklahoma City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at Chicago. Secy., D. K. Shedd, Ames, Iowa.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

The Engineers' Society of Western Pennsylvania, through the board of elections, has nominated the following for office during 1917: President, A. L. Hoerr; vice-president, George H. Neilson; treasurer, A. E. Frost; directors, E. W. Pittman, George H. Barbour.

The American Society of Safety Engineers has elected the following officers for 1917: President, Harry H. Dehn; vice-president, Cornelius Van Horn; treasurer, Leonard W. Davies; secretary, W. John Pedroncelli. The next regular meeting will be on Nov. 22 in the Engineering Societies Building, New York City.

The Oklahoma Society of Engineers will hold its annual meeting in Tulsa, Dec. 27 and 28, at the Chamber of Commerce, the first session opening 9 a.m., Wednesday. At the last meeting the membership was boosted from 41 to 75, and an equally encouraging increase is hoped for this year. The secretary is H. G. Hinckley, Oklahoma City.

The Paving Brick Institute will be conducted on Dec. 5 and 6 in Cleveland, at the Hotel Statler. The meeting will close with a dinner, for which a large program is promised. The subjects for discussion include the use of powdered coal, producer gas in burning brick, equipment efficiency, labor and the development and application of a bonus system.

The Galveston (Tex.) Engineers' Club, recently formed by members of the engineering department of the Gulf, Colorado & Santa Fe Ry., met to elect officers on Nov. 1. Membership is not limited to employees of the Santa Fe, but is purposed to be as broad as that of the usual local engineering society. Three meetings have been held thus far, and the membership list numbers 25.

The New York Railroad Club at its annual meeting on Nov. 17, in New York City, elected the following officers: President, James Milliken, Superintendent of Motive Power, Philadelphia, Baltimore & Washington R.R.; vice-presidents, Sidney Chambers, C. L. Bardo and Miles Bronson; treasurer, R. M. Dixon, and secretary, Harry D. Vought, 95 Liberty St., New York City.

Society of Automobile Engineers—In order to have one authoritative body dealing with the matter of standards for internal-combustion engines used on vehicles of all classes, the Societies of Aëronautic Engineers and of Motor Boat Engineers have decided to consolidate with the Society of Automobile Engineers, and the name of the society is likely to be changed to the Society of Automotive Engineers. It is probable that the association of engineers engaged in building farm tractors will also join this consolidation. Coöperation will be arranged, it is expected, with the American Society of Agricultural Engineers and the National Gas Engine Association. It is planned to have one vice-president to represent each special field of engineering covered.

Appliances and Materials

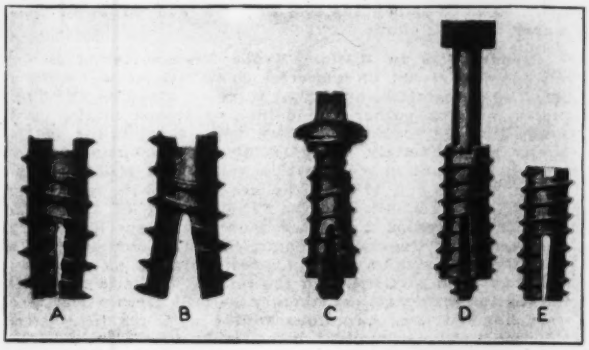
Colloidal Bitumens

Patents have been granted to Clifford Richardson, consulting engineer, New York City, on "the introduction of clay in the form of a colloidal aqueous paste and the combining of this paste with bitumen in such a way that when the water is subsequently driven off the bitumen forms the continuous phase of the colloidal material." The effect of the added colloidal matter is to give stability to the bituminous substances. It is possible to obtain with the proper amounts of asphalt and clay a material much resembling vulcanized rubber.

* * *

Expansion Sockets for Bolts and Screws

The "Tenax" expansion socket for anchoring screws and bolts into walls, railway ties, etc., is a French invention that is being tried with screw-spike track fastenings for rails on the Delaware, Lackawanna & Western R.R. It is on the same principle as the Lakhovsky (French) fastening



EXPANSION SOCKET OR ANCHOR FOR BOLTS AND SPIKES

used with screw spikes on the Pennsylvania Lines. The "Tenax" device is a malleable iron sleeve, threaded on the inside to fit the bolt or screw, and having on the outer side a sharp spiral thread to form an anchor. The lower part of the sleeve is split, and the sides here are pressed together so as to slightly reduce the normal diameter. The hole bored in the tie is threaded with a tap corresponding to the exterior thread on the sleeve, and the sleeve is then screwed into place. As the screw spike is screwed home it spreads or expands the split end of the sleeve, forcing the exterior thread into the surrounding wood. For use in concrete, the sleeve is set in its expanded position with the screw or spike in place, the interior threads being greased. After the concrete has set, the bolt is removed, until the piece which it is to hold is put in place. At A and B in the accompanying sketches are sections of the socket in open, closed and expanded position; C and D show the socket applied to a screw spike and bolt respectively; E is a view of the socket in normal position. The device is manufactured (under the Wagner patents) by Le Tenax Co., 6 Rue de Mont-Thabor, Paris (France), and the Tenax Metal Expansion Socket Co., 58 Lombard St., London (England).

* * *

Boiler-Water Purifier

A boiler feed-water purifier, to be submerged inside the boiler itself, has been designed by the Boiler Water Purifier Co., Bellevue Court Building, Philadelphia, and given the trade name "Economo." The water is led through preheating pipes run alongside a long horizontal treating tube, and is admitted to an end compartment of the latter. There is a horizontal central diaphragm extending nearly the length of the tube to give a long flow path. The scale is precipitated in the lower chamber, by heat action, and settles as sludge. The bottom of this lower chamber is bled by a blowoff. Partly submerged skimmer cones are piped, through check valves, to the purified-water discharge line and the feed-water inlet, so that when the purifier blowoff is opened, boiler pressure forces steam and boiler water through the whole apparatus to wash it out.